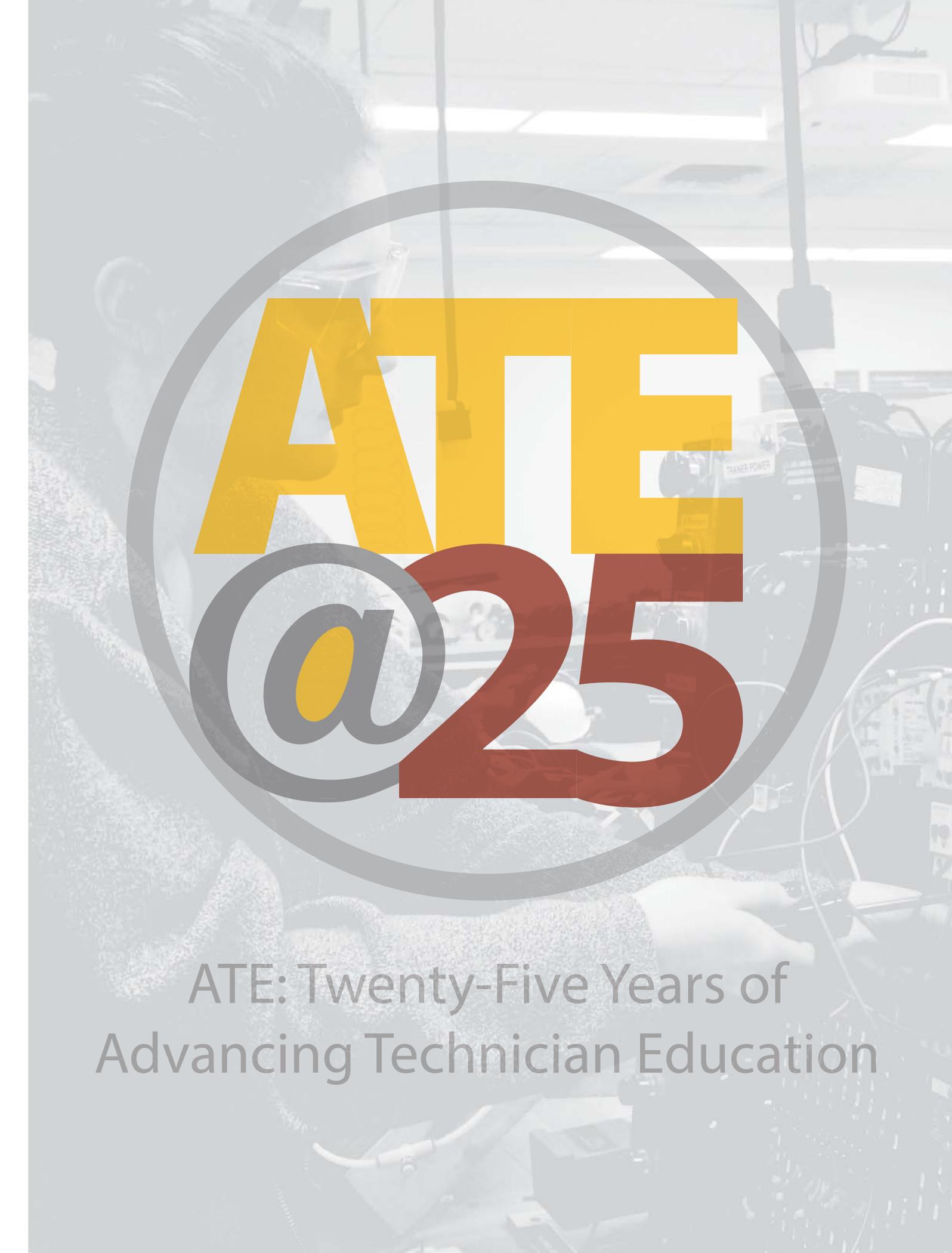# ADVANCED TECHNOLOGICAL EDUCATION IMPACTS

Twenty-Five Years of Advancing Technician Education
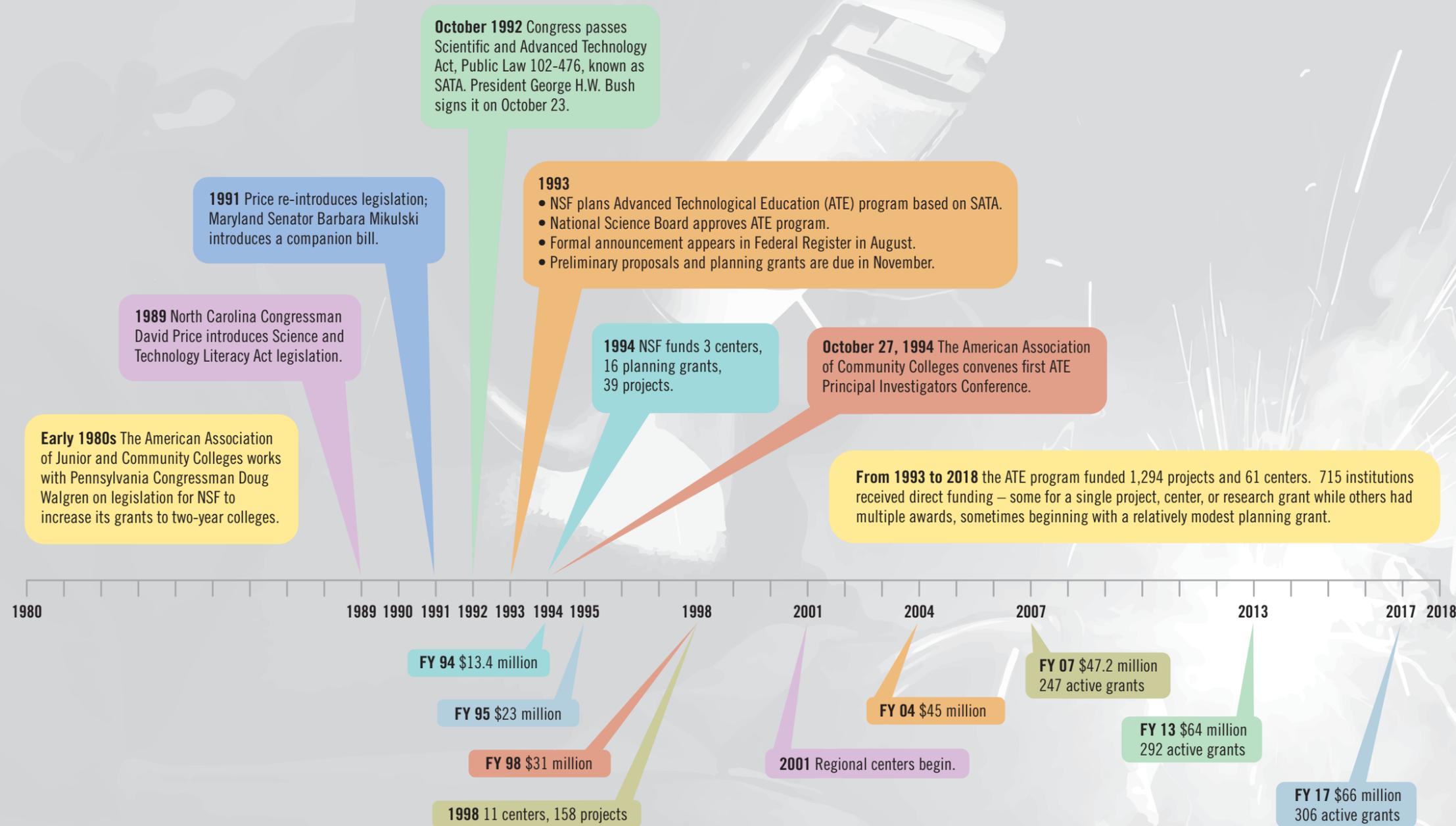
2018-2019

ATE

@25

ATE: Twenty-Five Years of
Advancing Technician Education

Twenty-Five Years of Advanced Technological Education

Building a Skilled Technical Workforce

NSF ATE Investment $1.11B

ATE@25

Funded by ATE
Centers **61** Projects **1,294**

Received ATE Funding
Institutions/Organizations **715**

October 1992 Congress passes Scientific and Advanced Technology Act, Public Law 102-476, known as SATA. President George H.W. Bush signs it on October 23.

1991 Price re-introduces legislation; Maryland Senator Barbara Mikulski introduces a companion bill.

1993
- NSF plans Advanced Technological Education (ATE) program based on SATA.
- National Science Board approves ATE program.
- Formal announcement appears in Federal Register in August.
- Preliminary proposals and planning grants are due in November.

1989 North Carolina Congressman David Price introduces Science and Technology Literacy Act legislation.

1994 NSF funds 3 centers, 16 planning grants, 39 projects.

October 27, 1994 The American Association of Community Colleges convenes first ATE Principal Investigators Conference.

Early 1980s The American Association of Junior and Community Colleges works with Pennsylvania Congressman Doug Walgren on legislation for NSF to increase its grants to two-year colleges.

From 1993 to 2018 the ATE program funded 1,294 projects and 61 centers. 715 institutions received direct funding — some for a single project, center, or research grant while others had multiple awards, sometimes beginning with a relatively modest planning grant.

1980   1989 1990 1991 1992 1993 1994 1995   1998   2001   2004   2007   2013   2017 2018

FY 94 $13.4 million

FY 95 $23 million

FY 98 $31 million

1998 11 centers, 158 projects

2001 Regional centers begin.

FY 04 $45 million

FY 07 $47.2 million 247 active grants

FY 13 $64 million 292 active grants

FY 17 $66 million 306 active grants

Sources: ATE Central, EvaluATE, and the National Science Foundation

National Science Foundation

The 25th anniversary of the National Science Foundation's (NSF) Advanced Technological Education (ATE) program offers a wonderful opportunity to reflect on the program's many achievements and recognize important ongoing efforts to enhance the nation's skilled technical workforce. The National Science Board's approval of the ATE program in 1993 began what has become NSF's largest investment in two-year colleges.

Institutions granting associate degrees play a pivotal role in the federal science agency's efforts to prepare a STEM-capable workforce. Through the ATE program, NSF encourages faculty at two-year colleges to serve as principal investigators of ATE centers and projects that expand technician education in science, technology, engineering and math (STEM), thus broadening participation in STEM among a more diverse population of students. NSF's efforts to transform these educators into STEM leaders and intentionally cultivate a sense of community among them further expands the program's impact and helps sustain ATE innovations after grant funding ends.

The educators and students directly impacted by the funded projects and centers are the most obvious beneficiaries. Yet, countless other students gain from the program thanks to the adoption and adaptation of ATE curricula, professional development workshops for faculty, student recruitment activities and other effective program deliverables and practices.

Meanwhile, ATE's historic partnership with industry provides important benefits to individuals and the nation as graduates of ATE-affiliated programs possess the technical skills and knowledge expected by high-tech employers.

For 25 years we have supported many wonderful educators at two-year colleges as they sought greater access to STEM learning for their students. Please join us in celebrating the accomplishments of the ATE program as it continues to build the nation's skilled and innovative technical workforce.

France A. Córdova
Director

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ATE Program Celebrates 25 Years of Improving Technician Education

In 2018 the National Science Foundation's Advanced Technological Education (ATE) program marks a quarter century of improving educators' teaching, broadening students' knowledge, and enhancing technicians' skills. ATE-initiated innovations have influenced advancements in teaching and learning in every state and across fields ranging from agriculture to photonics, and from environmental technology to information technology. The many accomplishments of the program and its ongoing, positive impact on education and industry for 25 years are cause for great celebration!

Fundamentally, the ATE program is the National Science Foundation's (NSF's) venture capital investment in community and technical colleges, the public associate-degree-granting institutions attended by nearly half of the United States' undergraduates. Collectively, these institutions enroll both the highest percentage of minority students and of first-generation college students. They are also where many scientists, engineers, and teachers begin their postsecondary education, or where they supplement the courses they take at four-year institutions. Through the ATE program, NSF has influenced the career paths of individuals from populations historically underrepresented in science, technology, engineering, and math (STEM) fields and added diversity—of thought, perspective, and experience—to the technical workforce.

By design ATE grants have encouraged experimentation and discoveries that have improved the knowledge and skills of new and experienced technicians working in advanced technology fields. The deliverables from ATE grants have also enhanced instruction in middle and high schools, in two-year community and technical colleges, and in four-year colleges and research universities.

The leadership of STEM educators from associate-degree-granting institutions in ATE projects and centers has added to the professional development of ATE grantees, who are known as principal investigators, while building capacity at their institutions and raising the profile of the two-year college segment of higher education.

Each ATE principal investigator has a distinct pursuit—an innovative idea that he or she has devised and described with evidence to persuade NSF review panels to recommend support for the grant proposals submitted to the federal science agency. Proposals that emerge through this competitive process have partnerships with employers in fields of strategic importance to the nation's economy and national security. ATE grants also often involve collaborations with other education sectors. After carrying out their ideas, ATE grantees share their results freely and make them available for others to adapt and adopt, expanding and extending the benefit of their work. Replication, the use of ATE courses, labs, and workshops as models by other educators, is an explicitly-stated program goal, and one that ATE grantees energetically pursue.

ATE Principal Investigator & Her Former Student Honored as Innovators

As an undergraduate Hilda Arguelles presented information at the 2000 ATE Principal Investigators Conference with Karen Wosczyna-Birch, her Tunxis Community College chemistry teacher. Arguelles provided the student perspective of the career pathway program that Wosczyna-Birch developed with an ATE grant, and explained how it helped her transition into the engineering program at Central Connecticut State University.

"Going to Washington was just a fabulous experience for a young person who was not really sure whether I was going to pursue a career in engineering," Arguelles said. Attending sessions where faculty shared outcomes from their ATE-funded activities stoked her excitement about a STEM career.

Since completing her bachelor's degree in engineering Arguelles has worked for Pratt & Whitney. With 17 years of experience in commercial and military engine overhaul and repairs, Arguelles now leads a team of engineers who evaluate the effects of repair processes on airfoils and hardware in commercial and military aircraft engines.

Arguelles and Wosczyna-Birch reconnected in 2018 when both were nominated in separate categories for Connecticut Technology Council Women of Innovation® Awards. Arguelles was nominated in the Large Business Innovation and Leadership category.

Wosczyna-Birch, who has been the principal investigator and executive director of the ATE-funded Regional Center for Next Generation Manufacturing since 2004, won the Academic Innovation & Leadership Award in the postsecondary category for creating "nationally recognized pathway programs between high schools, community colleges, and universities."

Karen Wosczyna-Birch (left), principal investigator of the Regional Center for Next Generation Manufacturing, and her former student Hilda Arguelles, a senior structures discipline manager in Pratt & Whitney's Global Services Engineering,

ATE Program History

When the ATE program began 25 years ago, its goal was to enhance the knowledge and skills of people beginning careers as technicians or already employed in the advanced technology sector. This mission to improve the quality of the US technical workforce was in place, but the details of how to accomplish it were not specified in the Scientific and Advanced Technology Act (SATA), except for Congress's stipulation that educators from associate-degree-granting institutions have leadership roles in the effort.

The original push to involve community and technical college educators in a federal government effort to improve technician education began in Congress in the early 1980s with advocacy from the American Association of Community and Junior Colleges. (The organization changed its name to the American Association of Community Colleges in 1992.) It was not until North Carolina Congressman David Price introduced the Science and Technology Literacy Act in 1989 that greater utilization of two-year college faculty received much attention, but that legislation did not get past committee hearings. In 1991 Price reintroduced his bill, and Maryland Senator Barbara Mikulski introduced a companion bill that wove funding for education in high-tech fields with economic
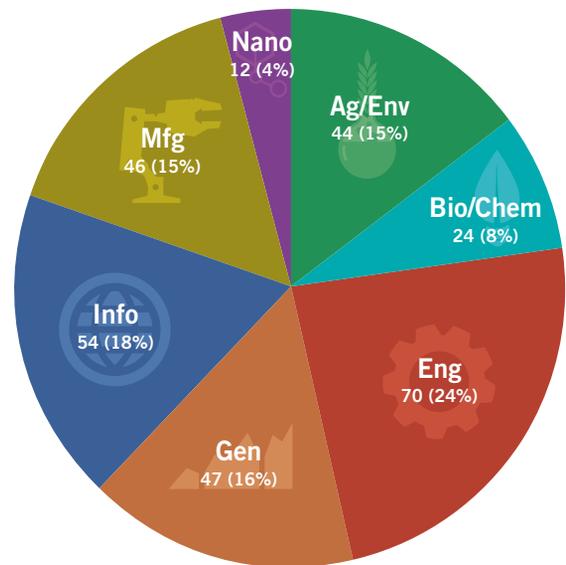
development for diverse populations. Their combined efforts gained bipartisan support that resulted in the Scientific and Advanced Technology Act (SATA) that President George H.W. Bush signed into law in October 1992. Following the National Science Board's approval of the ATE program, which NSF program officers created in response to SATA, it formally began in August 1993 with an announcement in the Federal Register.

The two NSF program officers—Elizabeth Teles and Gerhard Salinger—who were tasked with launching the ATE program in 1993 led it until 2009. To craft the first ATE program solicitation they combined the recommendations from *Gaining the Competitive Edge*, a report from an NSF-funded conference where scientists and educators offered advice on how to improve the technical workforce, with their own analyses of NSF programs and their experience as college educators and researchers.

One of the most unusual aspects of the solicitation was the requirement to partner with industry. Collaborations with educators were also encouraged. Teles and Salinger have said they had hoped that involving employers and multiple education sectors would help grantees to accomplish more and broaden the impact of the program. Their long-term goal was to create an integrated program, rather than a series of isolated grants. Since the 1990s, NSF program officers have continued to structure the program to foster collaborations between ATE principal investigators, employers, and other educators. As a result, the ATE program has cultivated a sense of community among the people who work on ATE projects and centers. In addition to the industry partnerships that ATE grantees are required to build, there is an esprit de corps among those involved in the ATE program. Grantees informally connect with each other throughout the year and collegially learn from each other during presentations and showcase sessions at the annual ATE Principal Investigators Conference. Ultimately the program has generated a welcoming community of innovative STEM education leaders.

In recent years the ATE program's co-lead program officers—David Campbell and V. Celeste Carter—have used the program solicitation to stimulate interest in cross-discipline initiatives and collaboration networks. To maximize the federal government's investment, the current program solicitation encourages grantees to plan for sustainability of the innovations developed and tested with ATE grant support. It also requires them to archive curricula and other materials with ATE Central, the program's centralized archive, to ensure that they remain accessible for others to use.

ATE Projects and Centers by Area (May 2018)

Pie chart data:
- Nano: 12 (4%)
- Ag/Env: 44 (15%)
- Bio/Chem: 24 (8%)
- Eng: 70 (24%)
- Gen: 47 (16%)
- Info: 54 (18%)
- Mfg: 46 (15%)

The current ATE program tracks include centers with budgets up to $5 million over five years; resource centers with budgets up to $600,000 over three years; targeted research on technician education with budgets ranging from $150,000 for pilot studies to $800,000 for full-scale research and development over three years; and projects with budgets ranging from $225,000 to $600,000.

Throughout its history the ATE program has benefitted from its team of forward-thinking program officers who have been proactive in helping support programmatic changes at two-year institutions in anticipation of workforce and technological advances. For example, in the late 1990s when the commercial applications of nanotechnology were nascent, the ATE program began funding projects to prepare technicians to work in settings that use micro and nanotechnologies. In 2002, as the Internet was just beginning to permeate economic and personal interactions and there was heightened attention to security in all its forms in the wake of 9/11, NSF collaborated with the American Association of Community Colleges to host a workshop exploring the role community colleges could play in the emerging area of cybersecurity education.

More recently, ATE grants have supported creative restructuring of student apprenticeships in the vastly differing fields of maritime transportation and enology, and faculty fellowships in biotechnology and advanced manufacturing to meet the evolving needs of employers, students, and educators.

Improving the Future Technical Workforce

From its initial round of funding a few dozen awards in 1994 to the wide array of centers and projects funded in 2018 in areas like robotics, sustainable construction, additive manufacturing, and geospatial technologies, the program continues to grow and expand. ATE principal investigators remain clearly focused on preparing technicians to use cutting-edge technologies and helping educators to develop innovative programs that respond to the evolving needs of the nation's advanced technology industries.

"The American Association of Community Colleges is proud of its long-standing partnership with the National Science Foundation on the Advanced Technological Education program.

"Since 1994, AACC has convened the annual ATE principal investigators' conferences and we are proud to be a part of a program where the investigators openly share their ideas and energy to make the ATE program a resource of effective strategies designed to meet students' academic needs, teach new technologies, and respond to employers' expectations.

"The endeavors of ATE principal investigators at community colleges, like the work done by technicians, are vital to the nation's economy and security."
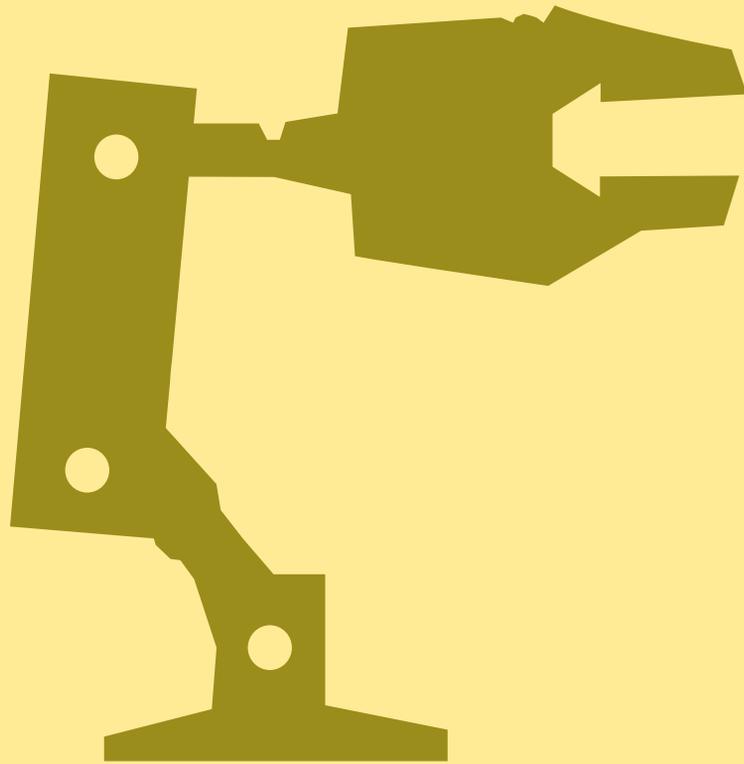
Walter G. Bumphus, PhD, President and CEO
American Association of Community Colleges

Advanced Manufacturing Technologies

http://ate.is/mfg

Mfg

CA²VES
Center for Aviation and Automotive Technological Education Using Virtual E-Schools

Clemson University, Clemson, SC
http://clemson.edu/ca2ves

CA²VES Equips Educators for Student Success

Providing access to high-quality digital learning tools (DLTs) has been a key mission of CA²VES from the beginning. The center has equipped thousands of learners in various educational stages with access to education-driven virtual reality simulations, customized learning curricula, and quality learning assessments that help instructors gauge learning comprehension.

CA²VES continues to partner with the Manufacturing USA Institutes to collaborate, assess, and deliver enhanced learning tools within the advanced manufacturing talent pool. These initiatives allow the center to provide broad dissemination of DLTs and, ultimately, enable learning institutions to provide industries with a qualified, technologically-proficient talent pool.

Key Activities
- Develops and disseminates quality digital learning tools.
- Produces education-driven virtual reality simulations.
- Broadens the capacity of the advanced manufacturing pipeline.
- Provides educational research and resources for two-year colleges.

A simulated hangar is part of CA²VES's new aircraft weight and balance course.

Future women engineers interact with CA²VES's immersive virtual reality during a STEM career program.

EducateWorkforce.com Expands

CA²VES has built an innovative online learning and dissemination tool, http://educateworkforce.com. Partnerships with high schools, two- and four-year institutions, other ATE centers, and businesses have allowed CA²VES to provide nationwide access to DLTs. These tools have been utilized to help educate more than 8,000 people in 42 states.

EducateWorkforce.com hosts 16 courses encompassing 108 learning modules and 86 virtual reality modules used to support the content. CA²VES has supported three statewide implementations of online courseware across the Carolinas including Manufacturing Skills Standards Council-aligned curricula and soft skills courses.

CA²VES Develops FAA-Aligned Curriculum

Through an effort to extend the availability of DLTs in the technological education arena, CA²VES has collaborated with Greenville Technical College to develop a 13-course curriculum suite aligned with FAA's Part 147 General Curriculum. This new curriculum is intended for the hybrid classroom and includes high-quality content, lectures using lightboard-style instructional videos, and CA²VES's education-driven virtual reality simulations. It is a great supplement to aviation maintenance technician programs and will be ready for instructors to test in 2018.

EducateWorkforce.com Usage

7,993
EducateWorkforce.com curricula users

3
Statewide implementations of EducateWorkforce.com program

42
States utilizing EducateWorkforce.com content

323
Online class sections across the US

CA²VES disseminates digital learning tools for technician education nationally via EducateWorkforce.com.

"Our partnership with CA²VES has allowed us to better engage our students through the use of digital learning tools, particularly the virtual reality simulations. Our instructors enjoy the supplemental curriculum resource, as well as the flexibility offered through the online environment."

David R. Barbour, EdD
Trade & Industrial Education Consultant
Career & Technical Education
North Carolina Department of Public Instruction

FLATE
Florida Advanced Technological Education Center

Hillsborough Community College, Tampa, FL
http://fl-ate.org

FLATE Broadens Its Student Reach

Since 2013 enrollment in FLATE-affiliated engineering technology (ET) degree programs increased from 1,109 to 2,062 in 2017. Female enrollment increased from 99 (9%) in 2013 to 226 (11%) in 2017. Minority enrollment also increased from 454 (41%) in 2013 to 969 (47%) in 2017.

FLATE has also reached more than 100,000 Florida students, educators, and community members through its Made in Florida campaign and industry tours.

FLATE focuses on Florida, but it has attracted participants from across the US and the world to its multi-day workshops and online webinars. In 2017 alone FLATE provided 9,089 hours of professional development to 3,268 educators and 2,280 workforce members, parents, and chaperons as well as to economic development and manufacturing personnel.

Key Activities
• Implements a statewide ET degree credential-based program aligned with MSSC and NAM certification systems.
• Promotes advanced manufacturing education through curriculum reform, outreach, and professional development.
• Broadens and strengthens partnerships with industry, education, and government organizations ensuring sustainability of FLATE projects.

Every summer FLATE hosts several Robotics and Engineering Technology Camps.

Articulation of ET Core & Degree Facilitates Workforce Entry

FLATE collaborated with its industry and academic partners and the Florida Department of Education (FLDOE) to design the state-wide Engineering Technology (ET) Associate in Science Degree Program. Now a national model, the ET degree offers a completely articulated program focused on a set of core courses aligned with stackable industry certifications offered by the National Association of Manufacturers (NAM) and the Manufacturing Skill Standards Council (MSSC). Aligned credentials help students accelerate their time to completion and enter the workforce more quickly.

Thousands of educators attend FLATE workshops and webinars each year to learn about manufacturing technologies.

The statewide articulation agreement provides 15 credit hours of the ET Core to anyone who enrolls in the program and has a current Certified Performance Technologist (CPT) credential. Therefore, anyone in the country who holds a valid MSSC-CPT credential can graduate with the ET degree after completing 45 credit hours rather than 60.

FLATE has mentored and supported 21 colleges in their adoption of the ET degree. FLATE also supports high school programs, especially those that offer MSSC certifications. It has facilitated the submission to FLDOE of three articulated high school frameworks and adapted the Advanced Manufacturing certification process for eight high school programs.

"FLATE has done an outstanding job providing a means for all educational institutions to share, develop, and leverage resources to meet the demand of the modern manufacturing employers of Florida."

Eric McClendon, Assistant Director
Pinellas Technical College

2017 FLATE Manufacturing Month Data

Counties	32
Students	5,070
Teachers	359
Parents & Chaperones	120
Student Tours	165
Student Surveys	2,202
Manufacturing Employees	515
In-kind & Cash	>$800,000

FLATE sustains Manufacturing Month tours and events with a coalition of manufacturers' associations, manufacturers, and educational institutions.

MSAMCOE
Minnesota State Advanced
Manufacturing Center of Excellence | ATE Regional Center

MINNESOTA STATE
Advanced Manufacturing Center of Excellence

ATE Regional Center

Bemidji State University, Bemidji, MN
http://360mn.org

Badges & Career Tool Engage Students

Through its leadership of Dream It. Do It. Minnesota, MSAMCOE (formerly known as 360) encourages students in grades 7 to 12 to pursue manufacturing careers. The Digital Badge Pathway created by Dream It. Do It. Minnesota allows students to earn badges, which are digital, verifiable representations of accomplishments. Students who complete the Digital Badge Pathway are eligible for 360 eTECH scholarships.

MSAMCOE's new Manufacturing Career Tool allows students to explore manufacturing careers. After watching videos about a day in the life of a manufacturing technician, students take a quiz to see how their skills and interests align with advanced manufacturing career fields.

Key Activities
• Offers youth activities as part of the Digital Badge Pathway.
• Provides Manufacturing Career Tool.
• Organizes industry tours.
• Coordinates dissemination of manufacturing career info.
• Sponsors VEX robotics state tournament.
• Encourages women to embark on manufacturing careers.

Thousands of girls and their families attend the annual Girls, Science & Technology event.

Center Builds Minnesota Workforce

MSAMCOE facilitates efforts at 19 partner colleges in Minnesota to increase the quantity, quality, and diversity of technicians in the advanced manufacturing workforce. Its largest outreach effort is the annual Statewide Tour of Manufacturing. The center coordinates the tours of manufacturing facilities. In 2017 alone, 17,554 people toured 138 manufacturers.

Center personnel also work with individual companies to develop their employees' skills. For instance, MSAMCOE helped a large Minnesota company utilize the center's 360 eTECH Online and Hands-on Manufacturing Education Program (http://360etech.org) for in-house training of new employees. By fall 2017, 18 of the company's employees had completed the 16-credit production technologies certificate.

Ongoing efforts to improve the center's manufacturing curriculum led to the standardization of 14 courses, the addition of hands-on activities for online manufacturing courses, and the expansion of weekend welding labs at two colleges. The development of a medical device manufacturing pathway that ties to the production technologies certificate is in process.

MSAMCOE also educates STEM teachers and robotics teams' coaches to spark youngsters' interest with accurate information about advanced manufacturing.

"We consider 360 eTECH a key partner in strengthening today's workforce and building the workforce of tomorrow."

Tim Walker, Employee Development Coordinator Pequot Tool & Manufacturing

Tours of Minnesota manufacturers include hands-on learning opportunities.

MSAMCOE Partners Hosting Manufacturing Tours

Year	Value
2011	48
2012	50
2013	67
2014	85
2015	132
2016	105
2017	138
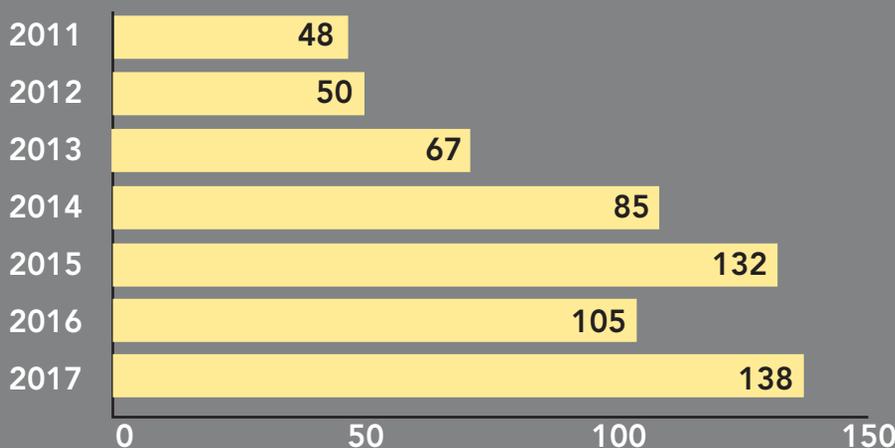
MSAMCOE coordinates the Statewide Tour of Manufacturing in Minnesota. In 2017 alone, 17,554 people toured 138 manufacturers.

RCNGM
Regional Center for Next Generation Manufacturing

Tunxis Community College, Farmington, CT
http://nextgenmfg.org

RCNGM Responds to Industry Needs

RCNGM distributes the biannual *Connecticut Survey of Manufacturing Workforce Needs* that addresses both workforce needs and the competencies of graduates from high schools, community colleges, and four-year universities.

RCNGM develops curricula in response to the needs of industry, which includes gaps identified from the survey data. The center's attention to industry feedback ensures that students graduate with the skills and knowledge they need for successful careers in advanced manufacturing. In 2017 alone, RCNGM developed and implemented eight new advanced manufacturing certificate programs to address employers' requests for technicians with skills in mechatronics, additive manufacturing, and metal fabrication.

Key Activities
- Offers hands-on learning experiences to generate interest in manufacturing careers.
- Instigates public awareness of modern manufacturing career opportunities.
- Offers programs in state-of-the-art manufacturing facilities.
- Develops industry-driven engineering and technology certificate programs, AS and BS degree pathways.

RCNGM's resources teach students to use equipment like 5-axis vertical CNC milling machines.

RCNGM Generates Interest in Manufacturing Careers

The primary impact of RCNGM has been to make students, educators, and other persons involved in career choices aware of the opportunities available in advanced manufacturing. RCNGM's *Manufacture Your Future 2.0* and *You Belong: Women in Manufacturing* videos and accompanying educator guides provide an overview of advanced manufacturing careers and RCNGM's manufacturing education programs.

RCNGM has also realized the importance of educating the community about advanced manufacturing careers and educational programs. Since 2015, it has organized three annual Greater Hartford Mini Maker Faires attended by several thousand people. Each faire attracted dozens of exhibitors from the community, manufacturing companies, and schools. Student exhibitors came from secondary schools and colleges, with many lively demonstrations of engineering and technology projects.

A technician compares the scan output with design software specifications.

"RCNGM has given me opportunities for hands-on technology experiences, learning about global sustainability practices, clarifying my career path, and net-working. RCNGM has also redefined my idea of 'community college' to include community of support, caring, and opportunity."

Elena Bolotova, Quality Associate TOMZ Corporation, 2018 Tunxis Community College Graduate

RCNGM works with regional and national partners to ensure the growth of advanced manufacturing. Regional and national partnerships with the Maker Movement, Manufacturing USA Institutes, and other NSF ATE centers and projects allow RCNGM to share its best practices with educators as well as industry and government representatives across the nation.

Credentials Earned through RCNGM Programs

Fall 2004	Fall 2017	Increase	Credentials Earned
598	2,205	269%	RCNGM Associate in Science (AS) Degrees & Certificates
296	957	223%	Engineering Science AS
302	1,248	313%	Technology Studies AS
27	370	1,270%	Manufacturing Certificates

Since RCNGM began in 2004, more Connecticut students have earned associate degrees in engineering and technology, and manufacturing certificates.

Weld-Ed
National Center for Welding Education and Training

Lorain County Community College, Elyria, OH
http://www.weld-ed.org

Weld-Ed Adds Non-Destructive Testing Module

Weld-Ed's newest professional development workshop covers non-destructive testing. It was developed in collaboration with Chattanooga State Community College to address the nation's need for individuals who can detect common metal defects and failure mechanisms such as cracking and corrosion. The Non-Destructive Testing Module, Weld-Ed's seventh professional development module for educators, covers radiographic inspection, ultrasonic inspection, and magnetic particle inspection.

More than 768 welding instructors have participated in at least one of Weld-Ed's seven professional development modules through 2017, reaching schools in 43 states and educating more than 44,200 students.

Key Activities

- Recruits diverse populations to welding careers.
- Offers educators welding modules to improve their knowledge and welding education instructional practices.
- Utilizes Mobile Welder Training Center to upgrade employed technicians' skills.
- Gathers and shares welding education and employment data.

"Through the welding industry research conducted and professional development courses created and delivered by Weld-Ed, the American Welding Society has received valuable guidance to improve the educational offerings provided to members and welding professionals."

Patrick Henry, Corporate Director, Education Services, American Welding Society

Weld-Ed's instructional materials teach students proper techniques for shielded metal arc welding and the science behind them.

Weld-Ed Programs Address Employers' Needs

According to Economic Modeling Specialists, Inc., there will be 1.4 million new and replacement welding-related jobs in welding occupations in the US by 2027. As an ATE Resource Center of Excellence, Weld-Ed addresses welding industry needs with a variety of educational programs.
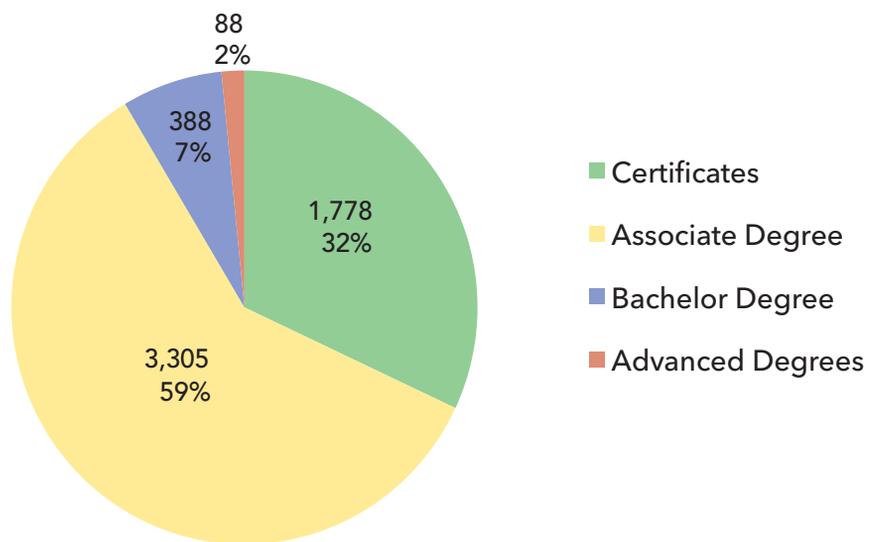
Since 2016, Weld-Ed has been making its Mobile Welder Training Center available to manufacturers, fabricating operations, and metalworking companies to upgrade the welding skills of their employees. The new 48-foot, self-contained semi-truck trailer is equipped with eight state-of-the-art welding stations to offer on-site customized training. The mobile training center was made possible through a grant from the Ohio Department of Higher Education in partnership with Weld-Ed and Lorain County Community College.

Weld-Ed in partnership with the American Welding Society offers recruitment materials to increase the number of underrepresented populations in welding careers. The center has supported welding education camps for secondary school students and other career programs. Across the 10 partner colleges, enrollment of Hispanic students in welding programs increased from 113 in 2015 to 156 in 2016, an increase of 38%.

Demand is high for technicians who have mastered gas metal arc welding techniques.

Student Outcomes of Weld-Ed Programs

- 88 / 2% — Advanced Degrees
- 388 / 7% — Bachelor Degree
- 1,778 / 32% — Certificates
- 3,305 / 59% — Associate Degree

Legend:
- ■ Certificates
- ■ Associate Degree
- ■ Bachelor Degree
- ■ Advanced Degrees

59% of graduates from Weld-Ed's 10 partner college programs have earned an Associate Degree in Welding Technology.

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Additive Manufacturing Workforce Advancement Training Coalition and Hub (AM-WATCH)

Tennessee Technological University, Cookeville, TN
http://am-watch.org

AM-WATCH Uses Array of Instructional Settings

AM-WATCH provides opportunities for secondary school and two-year college students and educators to learn additive manufacturing technologies. More than 700 students were impacted positively by the project from fall 2017 to spring 2018. During 2018 the project plans to add 30 locations to the 25 learning sites it has established in high schools, community colleges, and applied technology centers in Tennessee and Washington.

AM-WATCH's Train-the-Trainer Studios teach educators how to build 3-D printers to help them prepare technicians for additive manufacturing careers.

AM-WATCH also uses massive online open courses to inform audiences of all ages and skill levels about additive manufacturing trends, safety, innovations, and entrepreneurship.

Educators' Results from Train-the-Trainer Studios

77%
increased their ability to design a system, component, or process.

80%
increased their technical and nontechnical communication skills.

Educators report AM-WATCH's Train-the-Trainer Studios improved their performance on specific ABET accreditation skill sets.

Next Generation Multi-Craft Manufacturing Support Technician

Columbus State Community College, Columbus, OH
http://cscc.edu/community/grants/mmws

## Program Expands Use of Work-Study

ATE funding facilitated growth of the Modern Manufacturing Work Study program.

It began by combining five semesters of Associate in Applied Science in Engineering Technology degree course work with three semesters of on-the-job experiences. Successful implementation led to three more technology programs adding work-study opportunities.

A one-week summer institute of labs and facility tours introduces students to manufacturing environments and careers. Then, in their last three semesters of classes, students work 24 hours per week in paid work-study positions.

During spring semester 2018, while 22 graduating students finished work-study assignments with nine employers, 36 second-year students were interviewing for work-study positions with 15 industry partners.
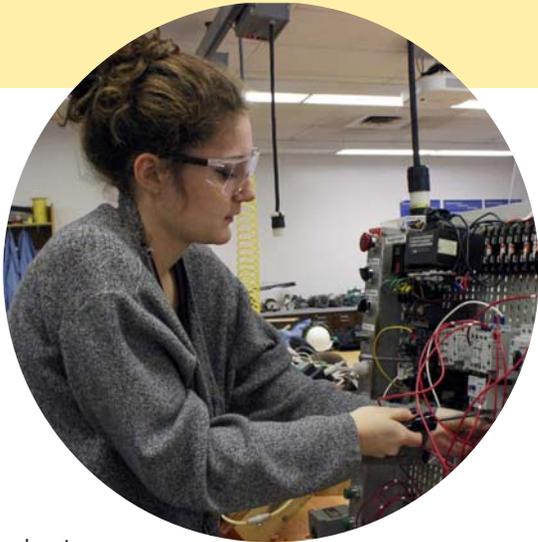
Second-year engineering technology students at Columbus State Community College learn in hands-on labs and at their paid work-study jobs.

People with Disabilities Achieving Career Employment (PACE)

University of Pittsburgh – Human Engineering Research Laboratories, Pittsburgh, PA
http://www.herl.pitt.edu/education/tech-training

PACE Prepares Veterans & People with Disabilities to be Technicians

The People with Disabilities Achieving Career Employment (PACE) program designs, develops, and delivers experiential curriculum tailored for veterans and people with disabilities. It also offers guidance to academic institutions and employers about making accommodations for individuals with disabilities in their advanced manufacturing programs.

PACE's curriculum prepares students with orthopedic, neurological, or cognitive impairments to become manufacturing technicians. Each module is taught by a different instructor. This exposes students to various instruction and management styles as well as workplace expectations.

As of October 2017, 83 students with disabilities had benefitted from the PACE program. More than 20 participants are either employed or enrolled in STEM education programs.

PACE prepares individuals with disabilities to work in advanced manufacturing or to continue their STEM education.

The STEM Guitar Project

Sinclair Community College, Dayton, OH
http://guitarbuilding.org

Guitar Building Captures Attention & Hones STEM Skills

The STEM Guitar Project engages students in an integrated learning system linking hands-on electric guitar-building processes with math, science, and engineering technology concepts.

The STEM Guitar Project learning activities align with core curriculum goals, as well as national education and industry standards. It is designed to nurture the skills and competencies that employers seek in technicians.

Since 2013, the STEM Guitar Project website usage has grown from under 2,000 views per month to an average of 5,750 views per month in 2017. Content on the STEM Guitar YouTube video channel is used in classrooms around the world, with nearly 1,000 subscribers and 272,000 video views.
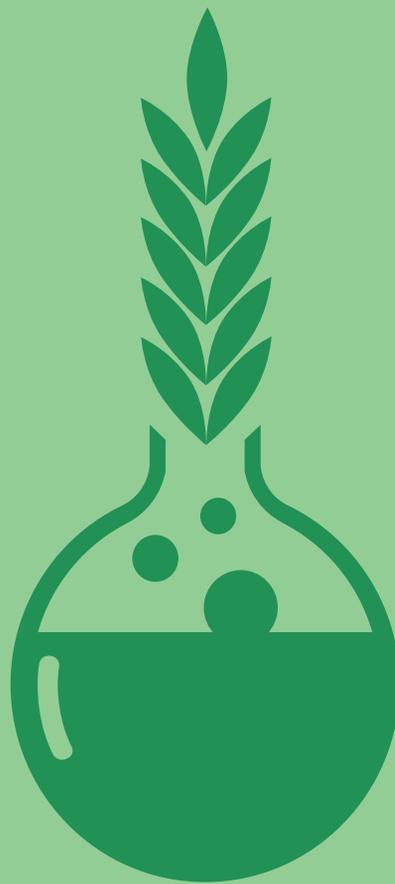
Schools in 48 states use the STEM Guitar Project's learning strategies. (Photo by James Huntington Cordero)

Agricultural and Environmental Technologies

http://ate.is/ag-env

AgEnv

ATEEC
Advanced Technology Environmental and Education Center

Eastern Iowa Community Colleges, Davenport, IA
http://ateec.org

ATEEC Engages and Empowers Students

ATEEC continues to impact students. Two examples with underrepresented students stand out. Since 2013, 36 students have performed research at ATEEC's partner Nahant Marsh as part of NSF's Louis Stokes Alliance for Minority Participation program. At least 10 are completing STEM degrees or working in a STEM field, with one in a PhD program.

In 2016, to increase awareness of career options, 328 Title I high schoolers explored ATEEC's Defining Technology reports and interactive Defining Careers charts to discover job details such as average pay, education needed, and community colleges offering programs. Counselors reported much higher engagement than usual.

Key Activities
- Facilitates efforts to recruit underrepresented populations to water, environmental, and energy careers.
- Offers research opportunities in environmental fields.
- Partners with business and industry experts to define technician knowledge, skills, and competencies.
- Curates and disseminates model educational materials.
- Supports and mentors institutions with water, environmental, and energy technology programs.

Environmental health and safety technicians approach a container while handling simulated hazardous material.

In collaboration with colleges and industry ATEEC developed curriculum that prepares chemical lab technicians for environmental occupations.

ATEEC Supports Educators with Information & Products

ATEEC broadly disseminates exemplary materials on its website to empower educators and impact students.

From 2013 to 2016, downloads increased 57% from new users and 34% from returning users (1,052 to 1,652, and 1,503 to 2,066, respectively). In 2016, http://EERL.org—the Environmental and Energy Resources Library of vetted STEM resources for educators and students—had 81% of 3,978 unique views result in downloads. ATEEC recently updated four of the seven Technology and Environmental Decision-Making modules it developed in 2003 with MIT to help educators incorporate the latest research into their curricula. The center has also updated its Defining Energy Technologies and Services report in response to many changes in the field.

"ATEEC has evolved throughout its existence by reading the environmental technology labor market and effectively meeting industry, educator, and technician needs. Its current focus on water technology is particularly relevant. These high-demand jobs are recession-proof and cannot be outsourced."

Cheryl Stith, Environmental Health & Safety Professional, Stith Consultants

ATEEC Continues to Innovate

In 2014, ATEEC became the first ATE center to develop interactive career charts. These webpages share statistics about jobs as well as links to community college websites with educational programs. The Defining Water Technology Careers chart has averaged 1,158 new visitors each year, with 28% returning to use the resource again, and staying about four minutes.

ATEEC recently began developing virtual and augmented reality training modules on water and wastewater with industry partner, EON Reality.

Usage of ATEEC Interactive Career Charts

Technology	Average New Viewers Per Year	% of Returning Users
Environmental	784	22.7 %
Water	1,158	28.0 %

Many users of ATEEC's new interactive charts access them repeatedly and stay about four minutes, which is much longer than the internet-wide average.

CREATE
Center for Renewable Energy
Advanced Technological Education

Madison Area Technical College, Madison, WI
http://createenergy.org

Profiles Feature Exemplary Programs, Faculty & Alumni

CREATE has produced a series of Renewable Energy Program Profiles to highlight model programs, exemplary faculty, and successful alumni. The Program Profiles are designed to help faculty nationwide to launch new renewable energy programs or to improve existing ones.

The Program Profiles highlight model renewable energy courses embedded in different types of community college programs. Each program profile incorporates a rich digest of statistics and information about the model program including a course syllabus, the program curriculum, and an interview with a faculty leader.

Successful alumni are also featured, and their stories provide useful models for prospective students pursuing careers in renewable energy.

Key Activities
• Provides mentoring for renewable energy faculty.
• Supports renewable energy industry, business, and academic partnerships.
• Promotes renewable energy technician careers.
• Addresses renewable energy technician knowledge, skills, and competencies.
• Distributes renewable energy instructional materials and curricula.

A CREATE Solar Institute participant wires an electric inverter to change direct current to alternating current.

CREATE Renewable Energy Institutes Respond to Faculty Input

CREATE Renewable Energy Institutes provide professional development for high school and two-year college educators. The institutes respond to a nationwide faculty-needs survey that identified the top content areas for professional development as solar photovoltaics, energy storage, and energy management; hands-on lab activities were the single most desired type of instructional material.

Accordingly, the CREATE Institutes blend a combination of applied academic content with hands-on technical experience. Participants work with full-scale renewable energy systems and with smaller bench-scale activities that are more easily replicated with students.
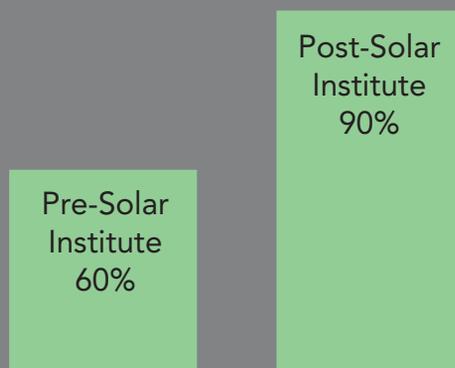
Participants in the 2017 CREATE Solar Institute increased their content knowledge measured by pre- and post-tests from 60 to 90%. All the participants—100%— reported that as a result of the workshop they are more likely to include renewable energy concepts in the courses that they teach.

The 15 participants of the 2017 Solar Institute reported they would teach more than 2,000 students in 2017-18. With a similar echo effect from future institutes, CREATE estimates the center will directly impact more than 100,000 students by 2020.

Madison College graduate Mike Reuter, in the blue helmet, leads a solar panel installation crew.

Solar Institute Participant Scores

Post-Solar Institute 90%

Pre-Solar Institute 60%

The median scores on tests of content knowledge taken by 15 educators who participated in the 2017 CREATE Solar Institute increased from 60% to 90%.

"The architectural technology program gave me my construction background, but then all the courses that I took through the renewable energy certificate program gave me my basis of understanding of solar electric systems."

Michael Reuter, Renewable Energy Crew Director, Wes Engineering Madison College Graduate

RCNET
Regional Center for Nuclear Education & Training

Indian River State College, Fort Pierce, FL
http://gonuke.org

RCNET Creates Sustainable, Standardized "Pipeline"

RCNET has matured into a viable workforce source for nuclear industries, thanks to an ever-expanding professional network of academic, industry, and agency partnerships. RCNET's largest impact is in the graduation of 3,607 two-year college students and job placement of 2,789 of them in the field with more than 100 industry partners.

By combining traditional classroom lectures with active learning, hands-on labs, simulations, access to unique training systems, and affective domain modules, RCNET has helped create a sustainable standardized "pipeline" of nuclear technicians. These technicians have the knowledge, skills, and ability for safe work in nuclear energy, environmental management, and life science fields.

RCNET students learn with virtual reality.

"RCNET has helped ensure the US has a robust and diverse nuclear workforce pipeline—one that is capable of leading the industry into the future in a safe reliable manner."

*James Auld, Director
of External Training Initiatives
NextEra Energy*

Key Activities
• Builds nationwide industry/ academic partnerships based on standardized models for energy, environmental management, and life science sectors.
• Improves nuclear technician education and training through professional development workshops.
• Develops cutting-edge curricula.
• Recruits and promotes diversity in nuclear workforce.

National Partnerships Shape New Generation of Technicians

From space exploration to the world's clean energy policy, nuclear energy is a cornerstone technology that helps advance society. At the heart of successfully advancing nuclear technology are well-equipped technical workers who can address the challenges of today and tomorrow. Above all else, these workers need to have the knowledge, skills, and ability to pursue careers in all types of nuclear industries.
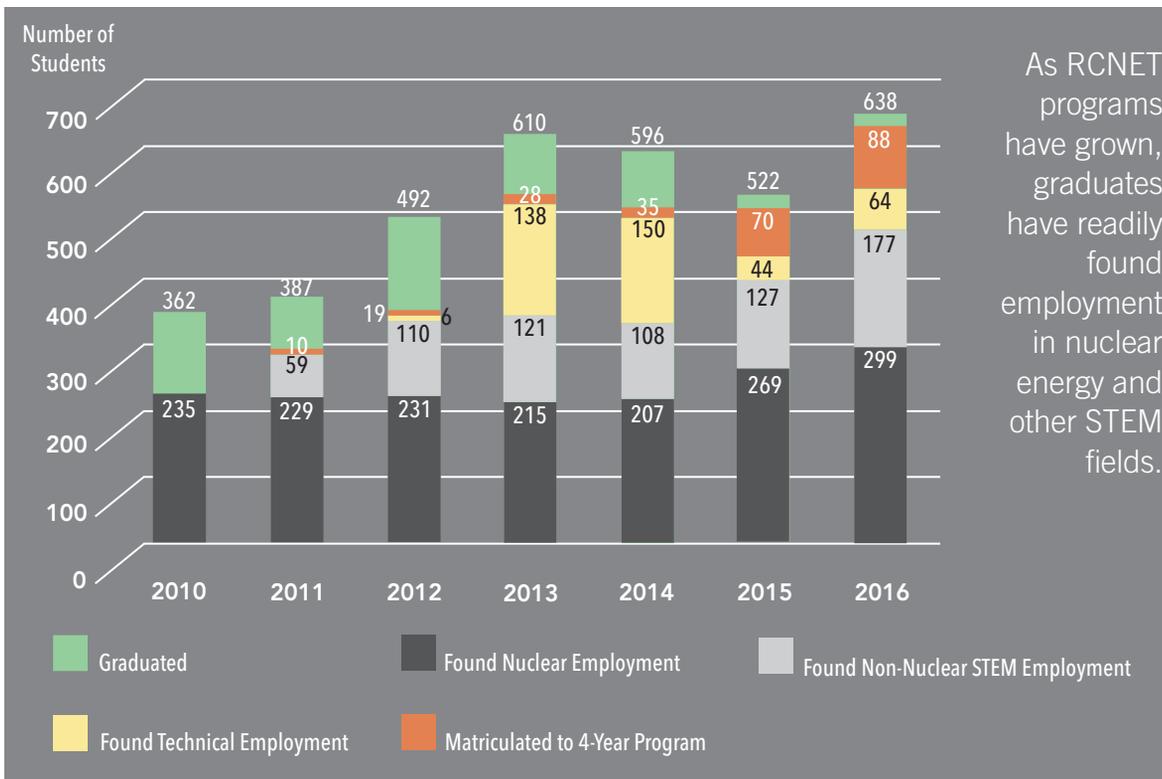
For this reason RCNET focuses on creating nationwide partnership models between academia and industry. The outcomes of these partnerships include standardized nuclear curricula and internships to educate the next generation of nuclear technicians.

Due to safety and security criteria, RCNET-affiliated programs educate technicians to very high standards. Multiple industries vie for RCNET's graduates. In energy fields, RCNET graduates are often hired into fossil, substation, transmission and distribution, hydroelectric, and smart grid jobs. By providing 21st century teaching materials and training educators with modern pedagogies, RCNET is helping not only the nuclear energy industry, but also the whole US energy infrastructure.
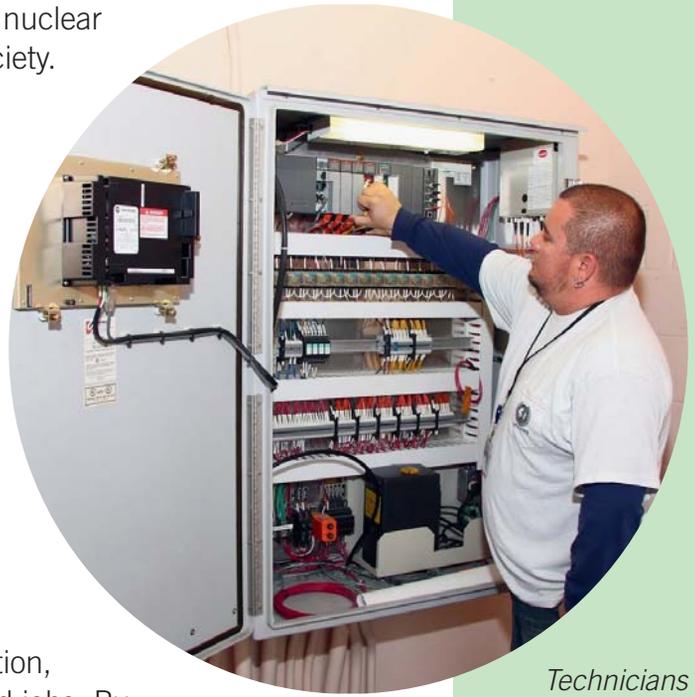
Technicians update their skills while working on a control panel in RCNET's dynamic flow loop.

RCNET Student Outcomes

Number of Students

Year	Found Nuclear Employment	Found Non-Nuclear STEM Employment	Found Technical Employment	Matriculated to 4-Year Program	Graduated	Total
2010	235					362
2011	229	59		10		387
2012	231	110		19	6	492
2013	215	121		138	28	610
2014	207	108		150	35	596
2015	269	127	44	70		522
2016	299	177	64	88		638

As RCNET programs have grown, graduates have readily found employment in nuclear energy and other STEM fields.

Legend:
- Graduated
- Found Nuclear Employment
- Found Non-Nuclear STEM Employment
- Found Technical Employment
- Matriculated to 4-Year Program

VESTA
Viticulture and Enology Science and Technology Alliance

Missouri State University, Springfield, MO
http://www.vesta-usa.org

Simulated Vineyard Enhances Learning

VESTA is enhancing students' preparation by developing a simulated vineyard and winery that will enable students to solve real-world problems in the virtual world. This will complement the knowledge acquisition in online courses and help students transition to the structured field experiences.

VESTA expanded its national network of vineyard and winery sites to 515 in 41 states and six other countries. These sites provide the structured field experiences embedded in most VESTA courses. The field experiences range from16 hours of observation in the introductory courses to 194 hours of hands-on tasks during the winery internship.

Key Activities
• Provides industry-validated knowledge acquisition through online courses for the grape and wine industry.
• Fosters skill development through structured field experience.
• Creates occupational competencies for grape and wine production jobs.
• Implements GIS course to address vineyard site selection and development.

A VESTA student operates a vine hedger in a Missouri vineyard.

VESTA Addresses Unique Industry Needs

More than 90% of the grape and wine industry consists of small businesses. Responding to the needs of small business owners, VESTA continues to expand its course offerings that integrate the STEM foundations into developing and expanding vineyard and winery business operations. Nine additional courses were implemented recently including Wine Business Feasibility, Facility Design, Finances, and Legal Aspects of Vineyard and Winery Operations.

The industry is dependent on a productive seasonal workforce that consists largely of persons not proficient in English. To address this need, VESTA implemented two courses that offer supervisors and managers the opportunity to communicate in Spanish on topics relevant to vineyard and winery operations.

To provide a structure in which employers can benefit from their existing and future workforce, VESTA is developing opportunities for the grape and wine industry to participate in the ApprenticeshipUSA program. Occupational competencies are being adapted to define the education and training needed for jobs within the industry, as well as assisting operators to identify and participate in federal and state workforce development programs.
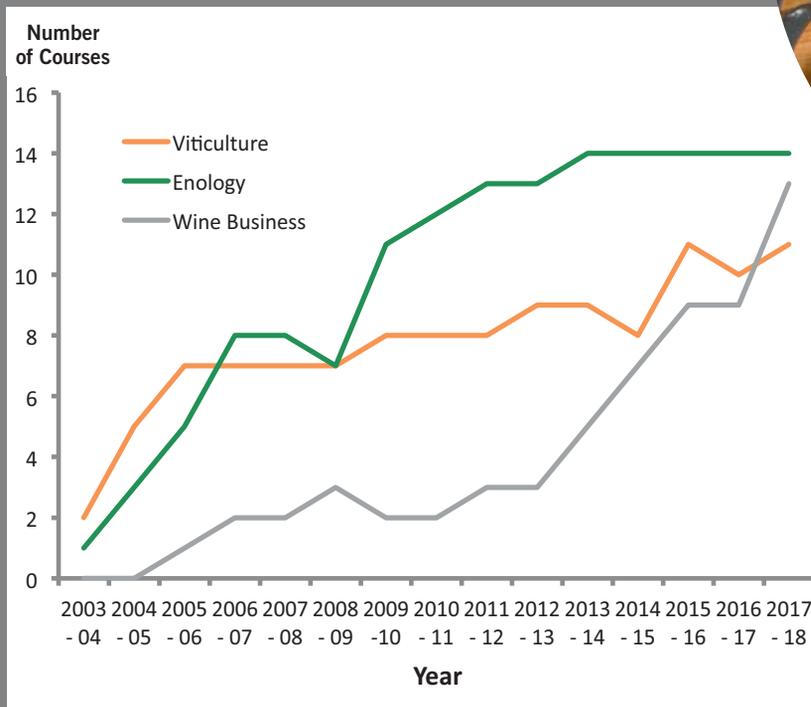
"[The VESTA] courses gave me a wealth of knowledge and that, with the partnering of the work with grapes, gave me a solid career foundation. Each course has built upon the knowledge gained from previous courses."

Denise Cimmarrusti,
Winery Operations Manager
AcquaViva Winery

VESTA's curriculum teaches complex winemaking techniques and the science behind them.

VESTA Courses

Number of Courses

Legend:
- Viticulture
- Enology
- Wine Business

(Line chart showing Number of Courses by Year, 2003-04 through 2017-18. Y-axis: 0 to 16. Viticulture rises from about 2 to 11; Enology rises from about 1 to 14; Wine Business rises from 0 to 13.)

Year

VESTA now offers 11 viticulture, 14 enology, and 13 wine business courses to meet the needs of the small businesses that operate most vineyards and wineries.

Pathways for Alternative Energy Automotive Technicians

Columbus State Community College, Columbus, OH
https://www.cscc.edu/community/grants/auto

Alternative Energy Automotive Program Educates New & Incumbent Technicians

Columbus State Community College is creating an Alternative Energy Automotive Technician program with its ATE grant as part of the collaboration of public agencies and private businesses working on Columbus's Smart Cities Challenge grant from the US Department of Transportation.

Leaders of municipal fleets, private fleets, dealerships, independent repair facilities, and energy advocacy groups encouraged the college's development of courses in hybrid/electric and alternative gaseous (hydrogen, compressed natural gas, and liquid propane) vehicle technologies.

The new stackable certificate aligns with an Associate in Applied Science in Automotive Technology degree. The college will begin enrolling new and incumbent technicians in fall 2018.

Columbus State Community College instructors and an employer discuss the lucrative nature of becoming a master automotive technician with potential students and their families.

Providing Opportunities for Women in Energy Related (POWER) Careers

Idaho State University, Pocatello, ID
http://isu.edu/estec/power-careers

POWER Careers Project Helps Women Become Energy Technicians

The POWER Careers project recruits and retains women in the engineering technology programs offered at Idaho State University's Energy Systems Technology Education Center (ESTEC).

It helps women 25 and older move past low-wage jobs to technician careers with annual salaries of $55,000 or more. It provides broad support from the time women express interest in power-related careers through graduation and job placement. The 11 female students who started in fall 2017 were 19.5% of ESTEC's incoming cohort. Since 2007, female enrollment averaged 9.3%.

Explaining that POWER Careers gave her confidence in her strength and intelligence, graduate Brandy Werre said, "I walk away proud."

The POWER Careers project helps women gain the skills they need to begin utility technician careers that pay family-supporting wages.

Strengthening Local Farms and the Rural Economy through Agricultural Mechanics

Snow College, Ephraim, UT
http://ate.is/SFAM

New Program Focuses on Family Farms

The Agriculture Systems Associate in Applied Science degree program addresses the needs of family farmers. It was created with the support of the Strengthening Local Farms and the Rural Economy through Agricultural Mechanics project grant.

Its curriculum combines courses from multiple disciplines—welding, diesel mechanics, agribusiness, and manufacturing technology—with instruction about advanced technologies such as global positioning systems and unmanned aerial vehicles.

A program recruiter will visit every Utah high school during 2018 to tell students about the program that prepares graduates to operate their families' farms efficiently, or to work as technicians for commercial farms or equipment dealers.

Operating unmanned aerial vehicles to monitor irrigation systems, crops, and livestock is one of the multidisciplinary skills taught in Snow College's agriculture systems program.

UPDATE: Utilities Pipeline Development for Advanced Technological Education

Northeast Wisconsin Technical College, Green Bay, WI
http://ate.is/UPDATE

Enrollees from Recruitment Events Persist at High Rates

The Utilities Pipeline Development for Advanced Technological Education (UPDATE) project recruits high school students to utility and energy careers with Tech Camps and Utility Preview Days. UPDATE's job fairs connect the college's utility students with employers.

Forty-seven students earned Gas Utility Construction and Service Technical diplomas in 2017; 97% were hired immediately with an average salary of $57,663. Forty-one students earned Electrical Power Distribution Technical diplomas; 100% obtained jobs with an average salary of $65,514.

The college leveraged UPDATE to secure a $150,000 state equipment grant, $400,000 in industry equipment donations, and voters' approval of a $7.1 million building project.

Student Outcomes of Utilities Preview Day Programs				
	2013	**2014**	**2015**	**2016**
UPD Attendees	82	68	83	82
UPD Attendees Who Enrolled in the Next Year	22 (27%)	19 (28%)	34 (41%)	34 (41%)
Of Those UPD Attendees Who Enrolled in the Next Year, the # Who Graduated	21 (95%)	18 (95%)	34 (100%)	34 (100%)
Percentage of All Utility Students Who Graduated	85%	87%	88%	87%

Nearly all of the high school students who attended Utilities Preview Day (UPD) programs and then enrolled at Northeast Wisconsin Technical College graduated with either gas utility or electrical distribution diplomas.

33

Bio and Chemical Technologies

http://ate.is/bio-chem
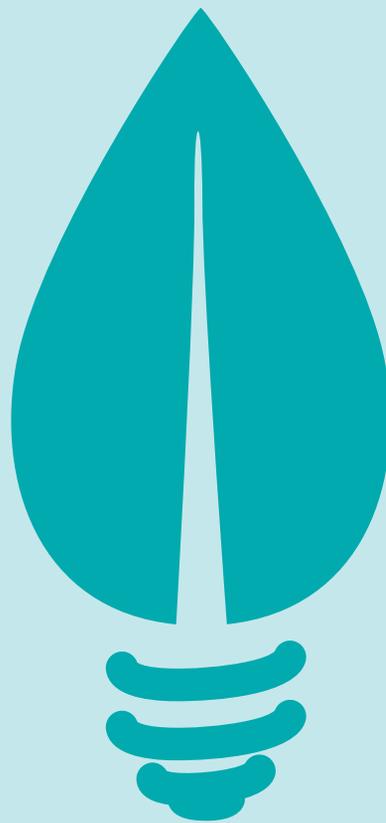
Bio/Chem

AC2
AC2 Bio-Link Regional ATE Center

Austin Community College, Austin, TX
https://ac2.bio-link.org

ACC
AC2 BIO-LINK
REGIONAL CENTER

AC2 Partners Recruit & Retain Students

Using the biotechnology program at Austin Community College (ACC) as the model, AC2 is implementing the Biotechnology High School Career Pathway in Texas. Through the efforts led by partner Collin College (TX), AC2's advocacy has changed state policies and saved two key courses for the curriculum that introduces high school and community college students to basic biotechnology career skills.

Del Mar College (TX), an AC2 partner, is part of a national network that encourages educators to use undergraduate research to recruit and retain students. This endeavor has successfully served diverse populations. Del Mar's annual undergraduate research workshop helps educators to embed innovative research projects into coursework.

Key Activities
• Forms partnerships to develop curricula in emerging technologies.
• Implements tiered industry-validated credentials for workforce-ready high school and college students.
• Establishes articulation partnerships to help students complete degrees.
• Promotes undergraduate research to foster interest in biotech careers.

ACC Bioscience Incubator interns calibrate instruments for clients.

The Biotechnology High School Career Pathway curriculum emphasizes attentive observation and accurate lab records.

Incubator Interns Save Companies Time & Money

Since the ACC Bioscience Incubator opened in January 2017, it has hosted 16 companies; produced six full-time, seven part-time, and three contractor jobs; employed nine interns; and provided a variety of educational benefits for the community. The incubator saves companies time and money in product development by providing interns and equipment. The incubator's partnership with the AC2 Bio-Link Regional Center provides hands-on experience and instructional training in biotechnology topics. These activities include annual biotech training sessions for high school teachers and the Austin Stem Cell Teacher Academy.

"The ACC Bioscience Incubator provides access to a wealth of laboratory equipment and resources that are unavailable elsewhere at a reasonable price. In addition, student interns, support staff, and business mentorship programs have been key to EQO's success."

John Higley, Chief Scientific Officer
Environmental Quality Operations

Contract Service Organization Resources in the Works

Bluegrass Community and Technical College (KY), an AC2 partner, has made significant progress in developing the Bioscience Collaborative Educational Learning Laboratory infrastructure. Its Contract Service Organization (CSO)-Incubator Summit and *CSO Baseline Report* brought employers and educators together. A CSO network and a CSO toolkit are works-in-progress. The biotech incubator associated with Bluegrass Technical and Community College is scheduled to open in 2018.

AC2's bioinformatics course informs instructors who teach this emerging technology and prepares students to use bioinformatics when they enter the workforce.

Students' Attitudes Towards STEM Careers

- Plans to pursue a career in a STEM-related field
- Plans to pursue a career that has a laboratory research component
- Plans to take other research-based courses

Pre-Course n=45
Post-Course n=34
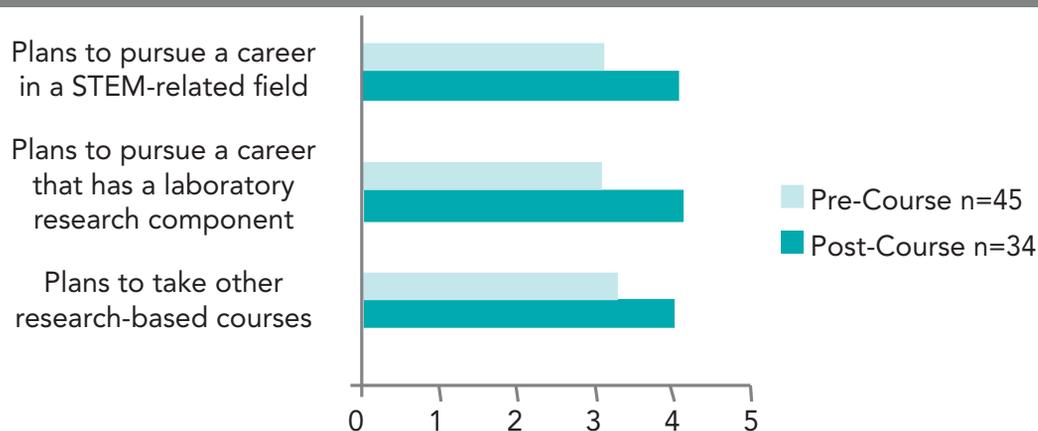
Before and after taking a research-embedded course, Del Mar College biotech students rated their STEM-related career plans on a scale of 1 (very unlikely) to 5 (definitely). Most indicated increased interest in STEM-related pursuits.

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BIO-LINK

Next Generation National Advanced Technological Education (ATE) Center of Excellence for Biotechnology and Life Sciences

City College of San Francisco, San Francisco, CA
http://bio-link.org
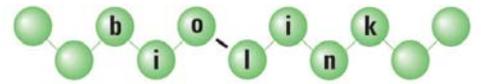
100% of Stem Cell Technology Completers & Their Employers Satisfied with Program

Efforts to promote career pathways in the emerging area of stem cells and tissue engineering have created new and exciting opportunities for students pursuing technical education through Bio-Link-affiliated programs across the nation.

Madison College (WI) has led this effort with the development of an industry-driven, two-semester program in stem cell technologies. By fall 2017, 84 students in six cohorts completed this stem cell certificate program with extremely positive outcomes.

- 95% found biotechnology industry employment.
- 100% of those who earned stem cell certificates and their employers report complete satisfaction with their education and the relevance of their acquired skills to workplace responsibilities.

Key Activities

- Promotes biotech careers at http://biotech-careers.org.
- Shares curriculum and instructional materials through Courses-in-a-Box.
- Provides networking opportunities and shares best practices with faculty at Summer Fellows Forum.
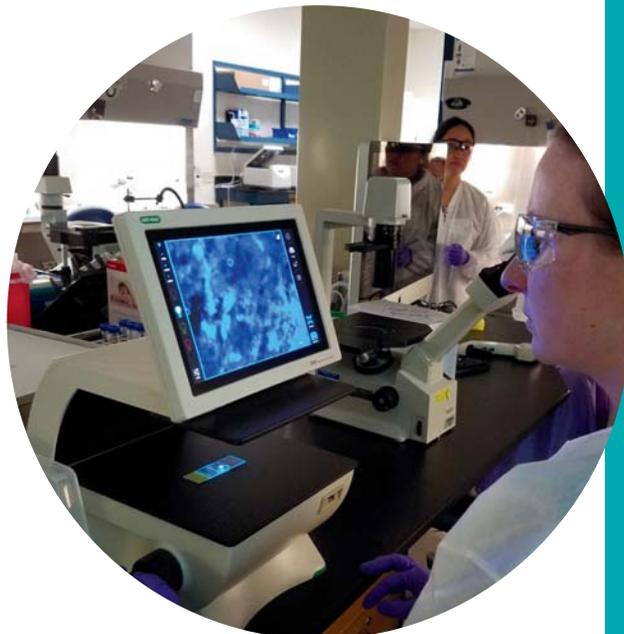- Created and fostered Equipment Depot as a non-profit.

Bio-Link's instructional materials teach students to use aseptic techniques to manipulate mouse stem cells in culture.

Expertise of College Programs Leads to Robust Partnerships

Through workshops, conferences, and educational forums, Bio-Link programs at Madison College and City College of San Francisco (CCSF) have provided more than 500 community college and K-12 educators with information, educational materials, and resources to adopt and integrate stem cell science into their classrooms.

Additionally, more than 150 biotechnology educators have participated in one-week Stem Cell Summits offered at Madison College, CCSF, Austin Community College (TX), and Bluegrass Community and Technical College (KY). Materials disseminated at these summits include lab and lecture resources and human cell-based and mouse cell-based curricula.

As Madison College and CCSF have established national reputations for excellence in workplace-focused instruction in stem cells and regenerative medicine, program leaders have been invited to collaborate with other organizations. These organizations value Bio-Link colleagues as strong academic partners with expertise in the education and training of skilled biotechnicians. The resulting collaborations have led to more than 200 commitments that link these two-year college biotech programs to other academic programs, as well as important industry, government, and community partners.

"We value our partnership with Bio-Link, the biotechnology faculty, and students who collectively provide an invaluable resource that enables us to develop, refine, and deliver a platform to meet the needs of advanced cell culture."

*Tori Sampsell
Vice President of Marketing
Cellara*

Bio-Link's professional development program teaches educators complex lab skills such as preparing human tissue cultures and using fluorescent microscopy.

Summer Fellows Forum Participant Ratings

98%
Rate Forum as Excellent

98%
Recommend It

In 2017, 40 of 41 Summer Fellows Forum participants who completed surveys rated the week-long workshop as excellent and would recommend that colleagues attend it.

NBC2
Northeast Biomanufacturing Center and Collaborative

Montgomery County Community College, Blue Bell, PA
http://biomanufacturing.org

NBC2 Impacts Student Education at Hub Colleges & Beyond

Since summer 2016, NBC2 has directly impacted more than 1,000 students at hub colleges and indirectly impacted approximately 3,700 more through high school teacher professional development.

More than 900 students enrolled in associate degree or certificate programs, and 100 high school students have attended NBC2's BIOMAN academies to engage in hands-on lab activities and to learn about careers in the biopharmaceutical industry.

Seventy-five college faculty attended NBC2 workshops and conferences receiving instructional materials and lab skills that impacted many biotechnology and biomanufacturing courses and programs across the country.

Key Activities
- Creates local and national networks of employers, educators, and organizations to provide a skilled biomanufacturing workforce.
- Supports faculty through mentoring, hands-on industry relevant workshops, and curriculum modules.
- Strengthens the STEM pipeline through high school workshops and career awareness initiatives.

"We submitted a curriculum and class syllabi for an AAS in biomanufacturing to academic advisers for approval. We were able to do that thanks to NBC2's tireless efforts and leadership to improve biomanufacturing education, and the NBC2 resources."

Alphonse Mendy, Instructor of Biology
Kansas City Kansas Community College

NBC2's advanced biomanufacturing curriculum educates students in aseptic cell culture techniques.

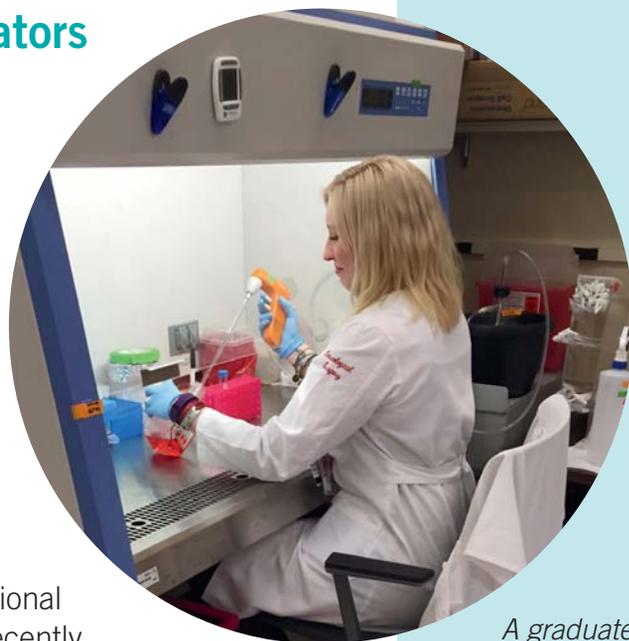# NBC2 Prepares Biomanufacturing Educators

NBC2 is dedicated to creating curricular materials to educate technicians in the development, production, and analysis of biopharmaceuticals and other bioproducts. These materials—developed to support hands-on learning and a theoretical understanding of the biomanufacturing process—were created in close collaboration with industry partners.

A biomanufacturing textbook, several production lab manuals, virtual training modules, and over 200 laboratory procedures have been developed. These materials are now open source and are being freely downloaded from http://biomanufacturing.org by students, faculty, and industry training managers.

A major goal of NBC2 continues to be the support and professional development of biomanufacturing college faculty. NBC2 has recently developed and made available:

A graduate from an NBC2 program performs mammalian cell culture in a biological safety cabinet.

- Four topic-specific miniBIOMAN workshops
- Four ready-to-insert curriculum modules
- A comprehensive biomanufacturing exam and test bank
- Lectures and resources to support the NBC2 textbook
- Program and course design resources and advising

NBC2 offers miniBIOMAN workshops on specific biomanufacturing topics in various locations. Assessments indicate that performing lab skills while learning from NBC2's cutting-edge curricula increases educators' knowledge, skills, and confidence.

Impacts of NBC2 miniBIOMAN Faculty Workshops

	Pre-miniBIOMAN	Post-miniBIOMAN
Knowledge	42%	83%
Skills	34%	69%
Intention to Incorporate Materials	60%	89%
Confidence	49%	82%

n=32
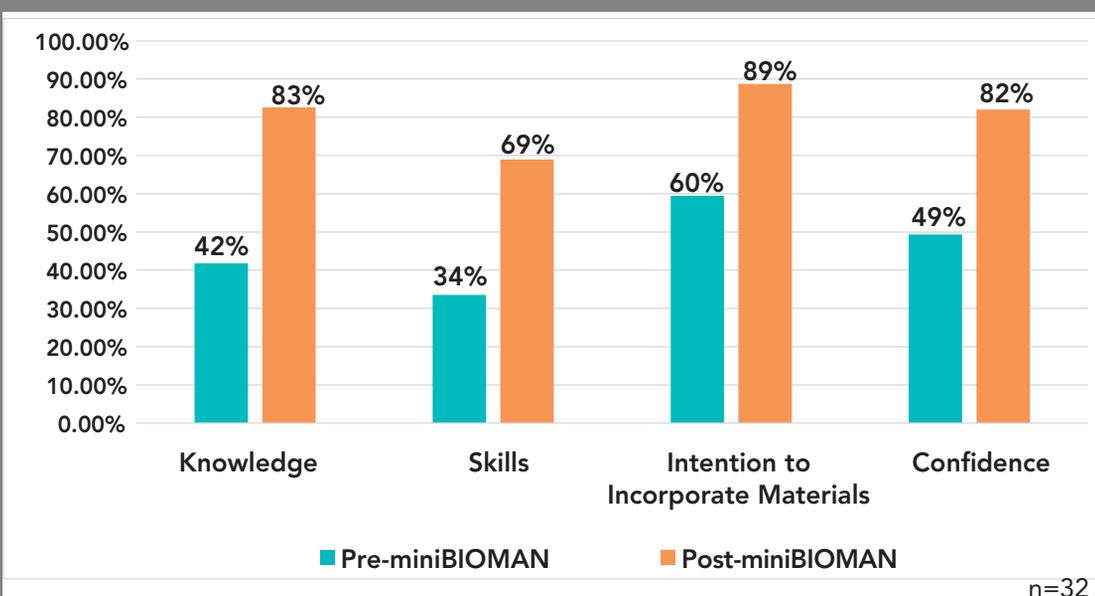
miniBIOMAN workshops on specific areas of biomanufacturing provide cutting-edge curricula and hands-on laboratory skills for faculty development.

Bioscience Industrial Fellowship Project

Forsyth Technical Community College, Winston-Salem, NC
http://biotechworkforce.org

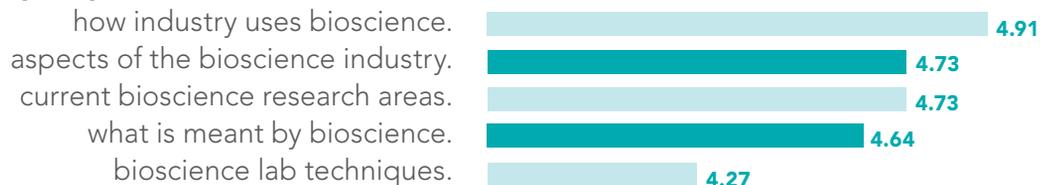## Bioscience Industrial Fellows Learn from Experts

The Bioscience Industrial Fellowship Project combines a one-month "boot-camp" of hands-on laboratory activities taught by experts, including educators from two ATE centers, with tours of bioscience industry facilities. Learning in this context enables the community college educators to make meaningful associations between classroom activities and workplace skills. They then produce inquiry-based curricula that integrate bioscience concepts and biomanufacturing processes to develop a better-prepared workforce.

The project both generates and sustains collaborations among community colleges, research universities, and bioscience employers to increase students' participation in technician preparation programs.

The 37 participants gave the project an overall rating of 4.7 on scale of 5. They reported:

The fellowship helped me better understand

how industry uses bioscience.	4.91
aspects of the bioscience industry.	4.73
current bioscience research areas.	4.73
what is meant by bioscience.	4.64
bioscience lab techniques.	4.27

Enhancing Hands-on Interactive Learning in Process Technology

Kenai Peninsula College, Soldotna, AK and Washington State University, Pullman, WA
http://ate.is/LCMIE

## Project Creates Low-Cost Miniature Industrial Equipment

Kenai Peninsula College and Washington State University faculty members teamed up to create low-cost, miniature industrial equipment kits and curricular activities to improve instruction of process technicians at two-year colleges.

The kits have the potential to replace expensive, bulky metal models and to allow implementation in classrooms and in students' homes. Their portability brings hands-on learning to in-class and online courses that previously relied on lectures only.

The project tested the lightweight, see-through equipment to teach about heat exchangers, eductors, and hydraulic pressure loss. Students who used the kits expressed more confidence about their career choices on surveys than students from lecture-only classes.

42
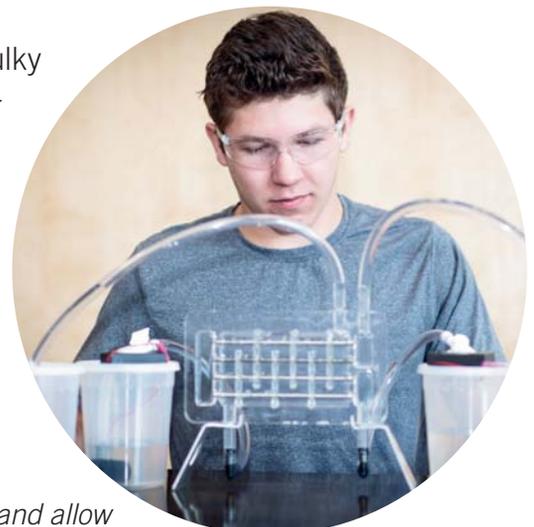
The heat exchange model and other kits ship easily and allow online students to conduct process technology experiments at home.

Orange County Biotechnology Collaborative Partnership

Santa Ana College, Santiago Canyon College, Fullerton College and Irvine Valley College, Orange County, CA
**http://ocbiotecheducation.org**

OC Biotech Teaches Skills That Employers Want

The four Orange County community colleges in the OC Biotech Education Partnership co-developed stackable certificates and degrees in biotechnology. The curriculum ensures students and incumbent workers gain proficiency with hands-on lab techniques and 21st century workplace skills. Students learn to read and write standard operating procedures, weigh and measure materials, use pipettes, handle liquids, make solutions, and operate industrial lab equipment.

From fall 2016 through summer 2017 the project placed 22 interns in industry or university research labs. Sixteen of the interns (73%) were offered part-time or full-time employment. The remaining six students continued as interns.

■ Offered Employment
■ Extended Internship

73%

27%
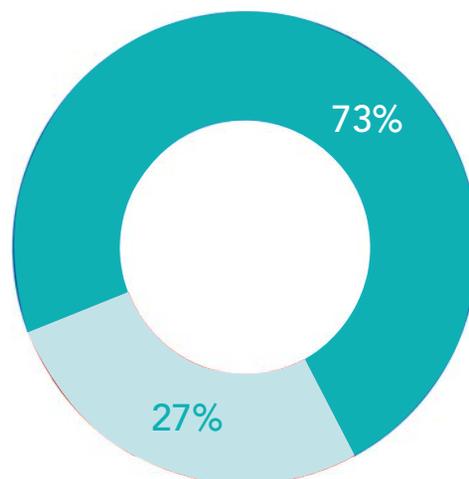
TeaM SCoRE Biotechnology

Flathead Valley Community College, Kalispell, MT
http://ate.is/TEAMSCORE

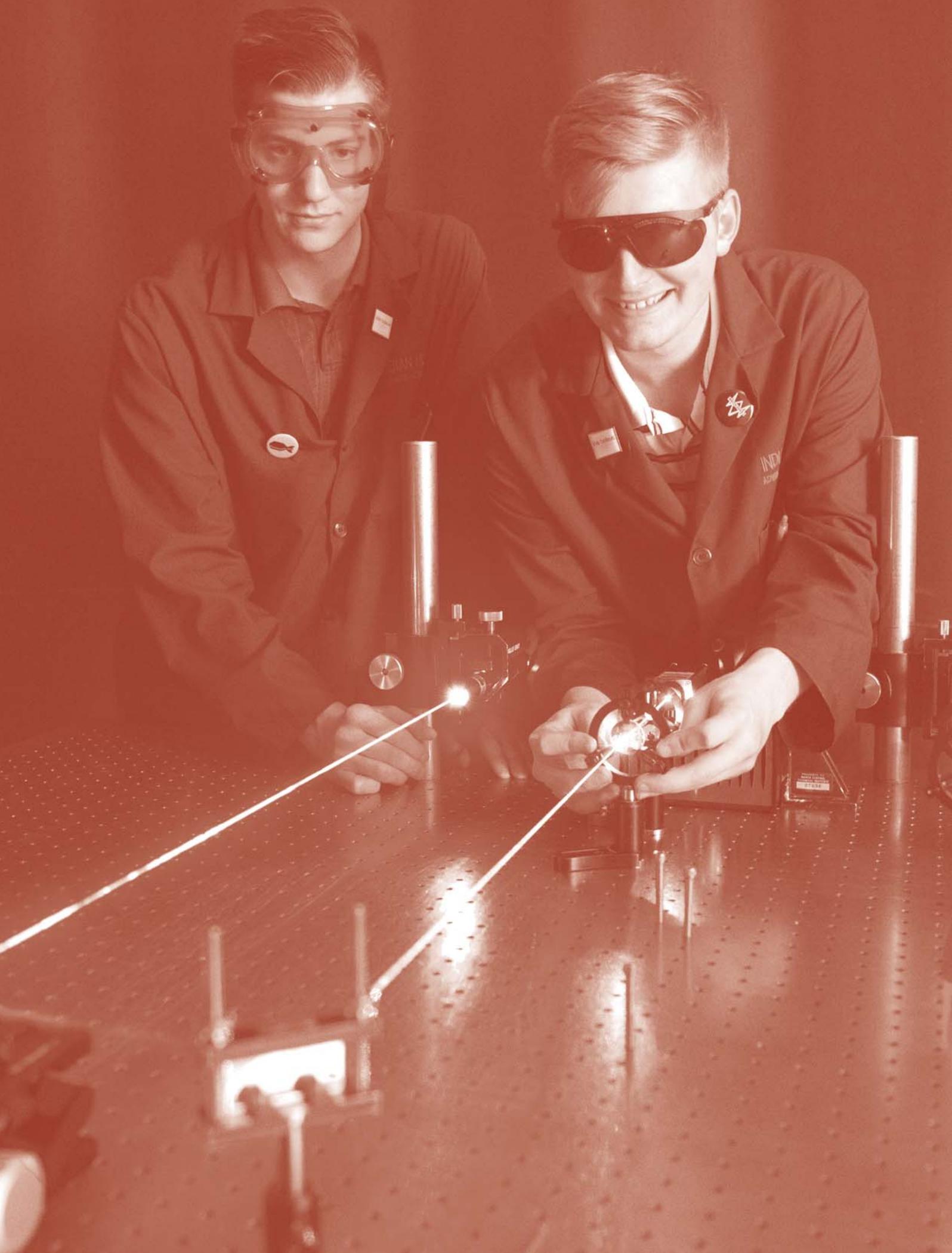## TeaM SCoRE Raises Biotech Awareness in Montana

The Teachers in Montana Strengthening the Continuity of Rural Education in Biotechnology (TeaM SCoRe Biotechnology) project provides professional development for high school teachers in northwest Montana. In addition to instructional guidance, the project offers equipment and supplies to implement innovative biotechnology lessons.

In 2016-2017, 18 of the 30 teachers who attended four, two-day DNA Bootcamp workshops added biotechnology lab activities to their classes attended by about 300 high school students. In fall 2017, 17 more teachers attended the workshops.

Flathead Valley Community College education students are also involved in the project's effort to raise awareness of biotechnology. They demonstrated DNA extractions and gel electrophoresis to 600 students in eight schools, simultaneously gaining pedagogical skills and biotechnology knowledge.
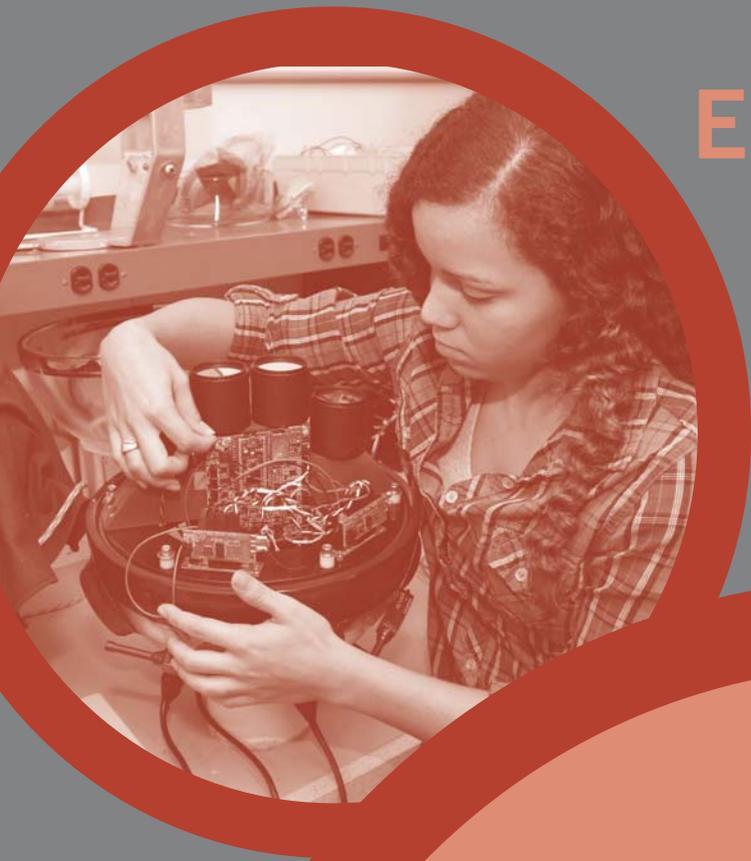

Flathead Valley Community College students participate in a plant DNA barcoding experiment, one of several biotech awareness events.

Eng

BEST
Building Efficiency for a Sustainable Tomorrow Center

Laney College, Oakland, CA
http://bestctr.org

BEST Inspires Innovative Curricula to Support Student Success

With support from BEST, colleges are developing new and improving existing programs:

- More than 20 colleges are developing or embedding building automation curricula.

- Five North Carolina colleges started Mission Critical Operations programs that combine facility operations, automation, and information security to improve emergency preparedness for critical facilities.

- Manhattan Area Technical College (KS) is designing a program to prepare technicians to operate a National Biodefense Lab.

- Faculty are adopting and sharing strategies for hands-on learning and lab development.

- Higher completion rates at BEST-assisted colleges mean more technicians are entering the workforce.

Key Activities

- Specifies technician knowledge and skills for high-performance building operations.
- Collaborates with industry and STEM organizations to strengthen technician career pathways.
- Provides professional development and technical assistance to faculty.
- Disseminates model curricula, lab designs, and problem-based learning strategies.

Building automation programs teach students to configure controllers for data collection and energy conservation.

BEST Develops National Certification for High-Performance Building Operations Professionals

BEST is developing the High-Performance Building Operations Professionals (HPBOP) certification as it leads community college efforts to design curricula that blend building automation and commercial heating, ventilation, and air conditioning (HVAC) with energy management. Graduates of community college programs aligned with the new certification are expected to be highly marketable because they will be able to operate buildings to save energy and ensure occupant comfort and productivity.

BEST has completed a nationally validated curriculum development process that identifies critical job-related tasks and key areas of responsibility. These tasks have been further analyzed by subject-matter experts to determine the skills and knowledge needed by high-performance building technicians. A certification exam will be developed to assess technician qualifications.

BEST Tests New Classes for Incumbent Technicians

Supported by three private utilities and the California Community Colleges Chancellor's Office, BEST has piloted classes for incumbent technicians and managers in high-performance building operations. The successful pilot confirmed the importance of developing the certification and has stimulated interest among public and private sectors to upgrade the building operations workforce.
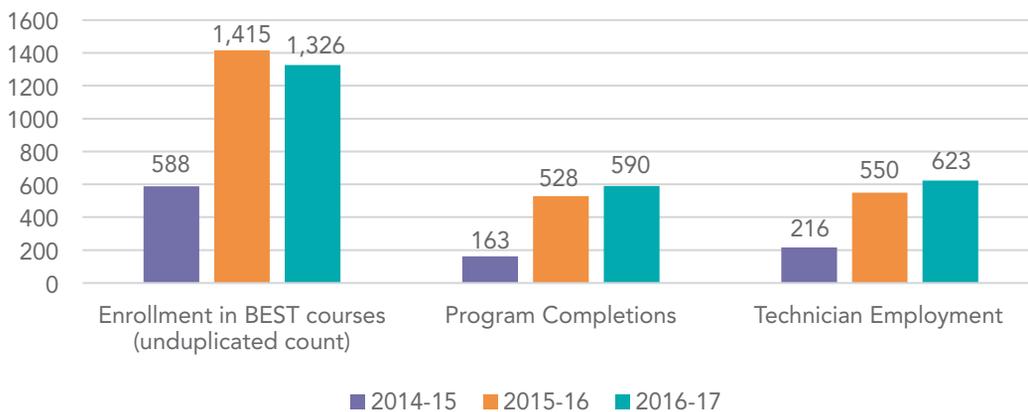
"We have a tremendous shortage of qualified technicians, and the prevailing issue is one of finding these individuals. Our attention needs to be focused on fostering talent at community and technical colleges, which have a vested interest in the industry."

Steve Hoiberg,
Higher Education Market Manager
Siemens

A building engineer ensures that a hydronic cooling system's pipes remain free of leaks.

BEST Student Completion & Employment Data

	Enrollment in BEST courses (unduplicated count)	Program Completions	Technician Employment
2014-15	588	163	216
2015-16	1,415	528	550
2016-17	1,326	590	623

BEST Center colleges are generating more program completers and technicians entering the field of building operations.

CAAT
Center for Advanced Automotive Technology

Macomb Community College, Warren, MI
http://autocaat.org

Center for Advanced
Automotive Technology
C · A · A · T

CAAT Prepares Students for Careers

CAAT seed funding has been used by 15 educational institutions to create more than a dozen complete courses and nearly 20 modules to prepare the workforce nationally for technical development jobs in advanced automotive technology. Kettering University (MI), for instance, developed a course on automotive materials lightweighting that was subsequently offered elsewhere.

CAAT reaches more than 4,000 middle school students each year through technical-focused career exploration and in-classroom STEM labs. After participating in CAAT's career exploration and classroom STEM labs, 82% of 4,102 middle school students who participated during the 2016-2017 school year indicated that they were interested in pursuing a STEM-related career.

Key Activities
• Creates and disseminates advanced automotive technology curricula via its website, which has had 83,000 unique visitors.
• Offers free professional development for educators, industry professionals, and government employees.
• Plans to offer a new vehicle development technician associate degree per industry's request.

Technicians test battery-packaging options as part of an electric vehicle project.

During Auto STEAM Days students modify a clay model car at General Motors' hands-on exhibit.

Partnerships Drive Skills for Next Generation Workforce

By working with 12 industry partners, CAAT identified the need for a vehicle development technician (VDT). This new type of technician will work on test and prototype systems with engineers at automotive companies and suppliers. Auto industry employers have requested that VDTs possess knowledge of electronics, computers, and experimental testing. In response to this industry need, CAAT developed a two-year VDT associate degree that includes courses developed by two educational partners under the CAAT's seed funding program. Macomb Community College will offer this new degree in fall 2018.

CAAT also leveraged its partnerships to

- develop and deliver a continuing education workshop on connected and automated vehicles for the Michigan Society of Professional Engineers;

- provide six technical training workshops on connected and automated vehicles and fuel cell electric vehicles for more than 600 automotive teachers attending the 2017 North American Council of Automotive Teachers Conference and the Southeastern Michigan Automotive Teachers Association Conference, which CAAT sponsors; and

- host a STEM Adventure Day for the Boy Scouts' Great Lakes Field Service Council.

"Auto STEAM Days are a great opportunity for students to see the many different aspects of automotive design. It gives them an idea of what they could look forward to if they decide to pursue a career in the automotive industry."

Leon Carpenter
Operations Product Manager
Ford Design Studio

2018 CAAT Conference Ratings

Bar chart showing:
- Extremely Valuable: 32%
- Very Valuable: 55%
- Moderately Valuable: 11%
- Slightly Valuable: 2%
- Not Valuable: 0%
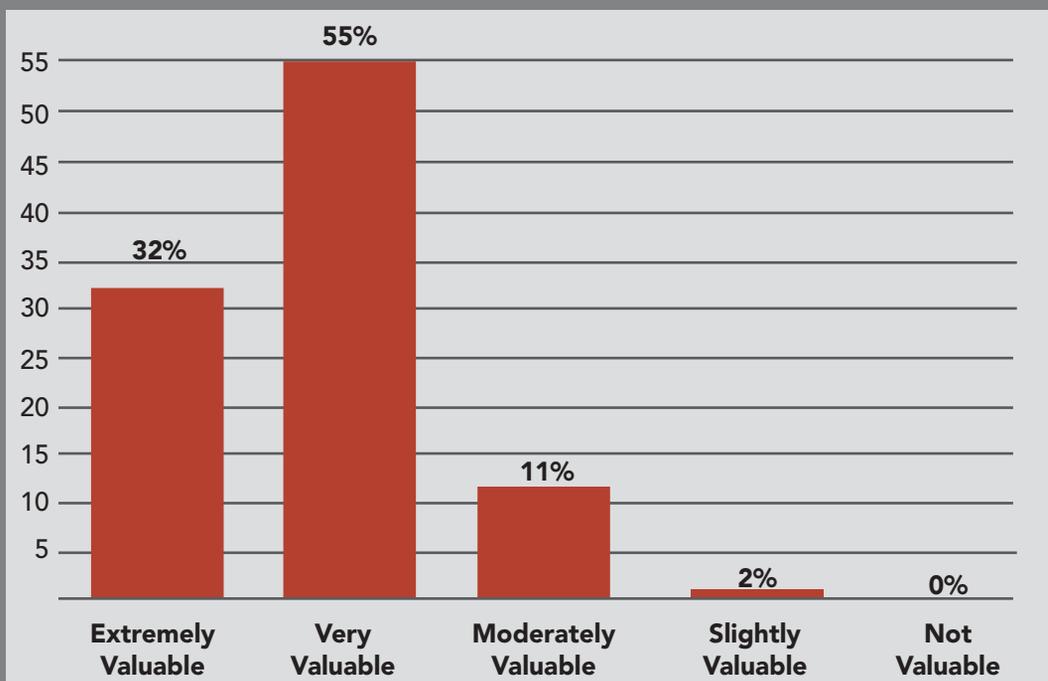
"Testing Tomorrow's Autonomous Vehicles Today" was the topic of CAAT's 2018 conference, attended by 156 people from 18 secondary schools, 11 community colleges, six universities, 16 employers, 18 professional or STEM organizations, and six government entities. All 76 survey completers rated it valuable.

LASER-TEC
Southeast Regional Center for Laser and Fiber Optics Education

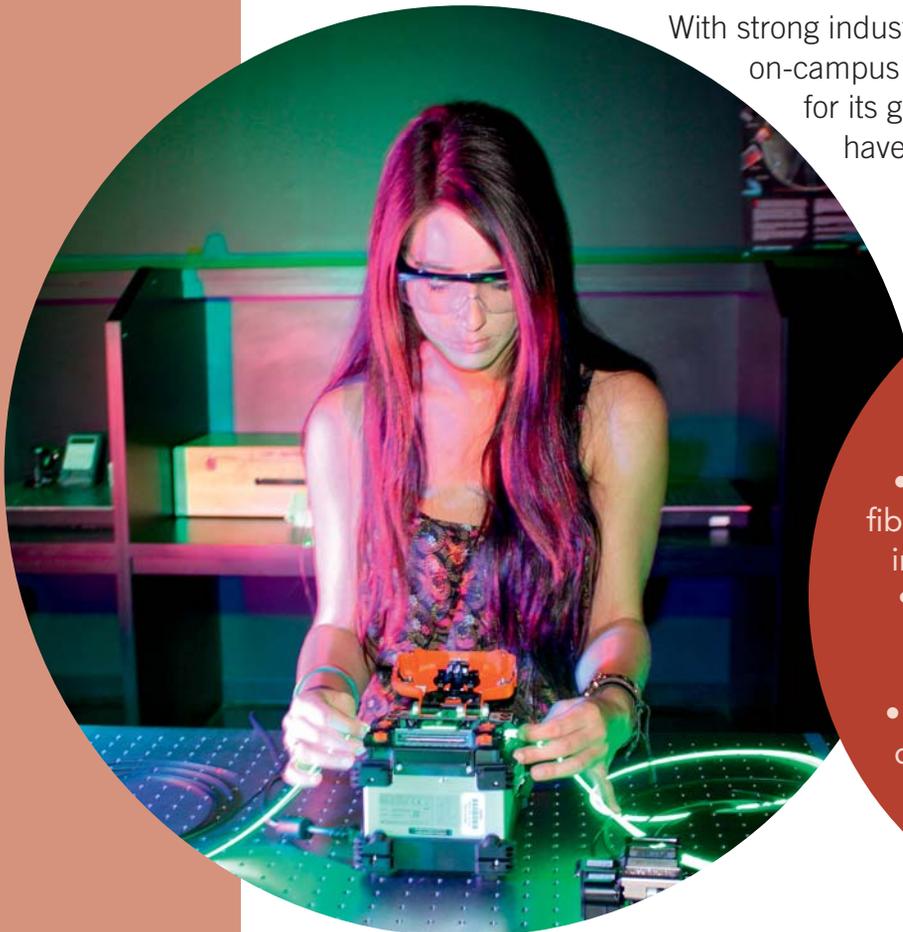**Indian River State College, Fort Pierce, FL**
http://laser-tec.org

More Students Persist in LASER-TEC Programs & Graduate with Multiple Job Offers

The number of students in LASER-TEC college programs has consistently increased since the center's establishment. In 2017, 223 LASER-TEC students were pursuing associate degrees to help them secure fulfilling careers in this emerging field.

LASER-TEC has developed remediation pathways to improve applicants' preparation to pursue degrees. Its cohort-based program design and continuous student support from academic coaches in combination with an academically stronger applicant pool have resulted in 95% retention rates at partner colleges.

With strong industry support LASER-TEC provides on-campus recruitment and placement opportunities for its graduates. Many LASER-TEC students have multiple job offers before they graduate.

Key Activities
• Graduates highly skilled laser and fiber optics (LFO) technicians educated in the latest industrial technologies.
• Develops instructional resources.
• Leverages partnerships to benefit students.
• Facilitates outreach and awareness campaigns to address the shortage

A LASER-TEC student performs fusion splicing of a single mode fiber optic cable.

Two-Fold Workforce Development Approach Yields Positive Results

LASER-TEC uses a two-fold approach to workforce development: fortify the current incumbent workforce and establish the new pipeline by supplying highly qualified graduates into the employment market.

More than 140 incumbent workers have received LASER-TEC training in fiber optics, laser technologies, telecommunications, and IP data networks. LASER-TEC training is developed and facilitated in partnership with global industry leaders such as Northrop Grumman, Corning Cable Systems, Fluke Networks, Transition Networks, NextEra Energy, PCS Fiber, Synoptics, and others.

The center has organized and facilitated 43 on-campus or on-site hiring sessions for LFO companies. These sessions enable employers to acquire qualified technicians, while providing LASER-TEC graduates with career opportunities. By 2017, 31 LFO companies hired more than 200 LASER-TEC graduates who are now working in different sectors of economy and in almost all 50 states.

"It has gotten harder and harder to get qualified people. With the LASER-TEC program we have the opportunity to pick someone who has been trained in accordance with our input."

Donald Hawkins
Vice-President, PCS Fiber

A fiber optics technician tests the quality of a link using an optical time domain reflectometer.

LASER-TEC Photonics Courses

	Number of Photonics Course Sessions	Student Enrollment	Student Semester-hours
2013-2014	7	108	789
2014-2015	10	148	1,332
2015-2016	16	153	2,012
2016-2017	18	223	2,746

With more LASER-TEC courses at six colleges, enrollment and credit hours per student increased.

MATE Center
Marine Advanced Technology Education Center

Monterey Peninsula College, Monterey, CA
http://www.marinetech.org

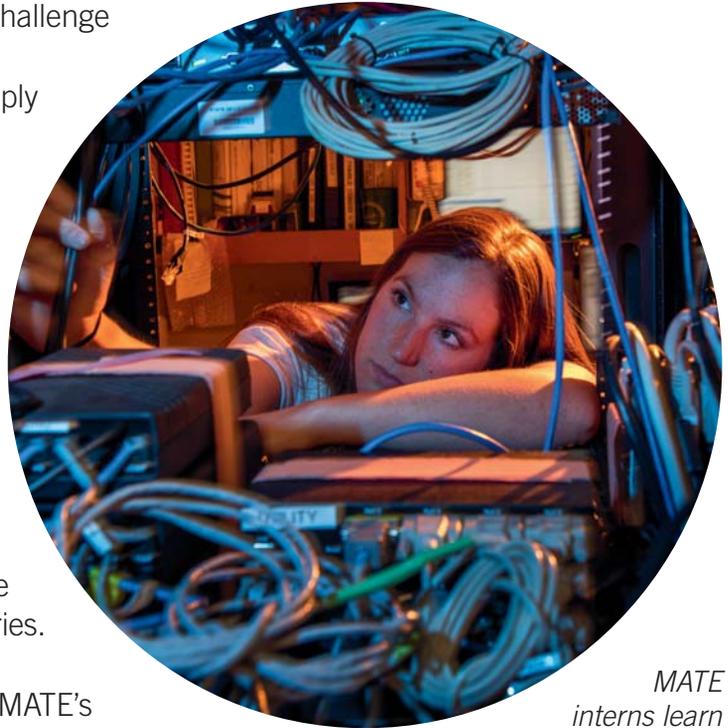**MATE**
MARINE
ADVANCED
TECHNOLOGY
EDUCATION
CENTER

MATE Puts Students on a Course to Succeed

MATE uses marine technology to challenge students to learn. Its curricula and activities encourage students to apply STEM creatively to solve real-world problems in ways that strengthen critical thinking, collaboration, entrepreneurship, and innovation.

MATE and its regional partners have coordinated 16 international and 237 regional ROV competitions that have involved more than 17,000 students in grades 4-16. These competitions have attracted student teams from 30 states, Puerto Rico and the District of Columbia, and 20 countries. In a survey, competition alumni reported MATE's ROV competitions have been instrumental in their obtaining jobs, internships, and scholarships, and in starting new businesses.

MATE interns learn ships' information technology and networking systems.

Key Activities
• Develops knowledge and skill guidelines for the ocean technical workforce.
• Organizes regional and international underwater robotics (ROV) competitions.
• Operates SeaMATE, a social enterprise that provides students with workplace experiences.
• Offers at-sea technical internships.
• Provides technology-rich professional development.

"I have been involved with the MATE ROV competition for the past 17 years. When I encounter new, talented professionals in the field, I'm not surprised to find they are former competitors. 'Made by MATE' means something in our industry."

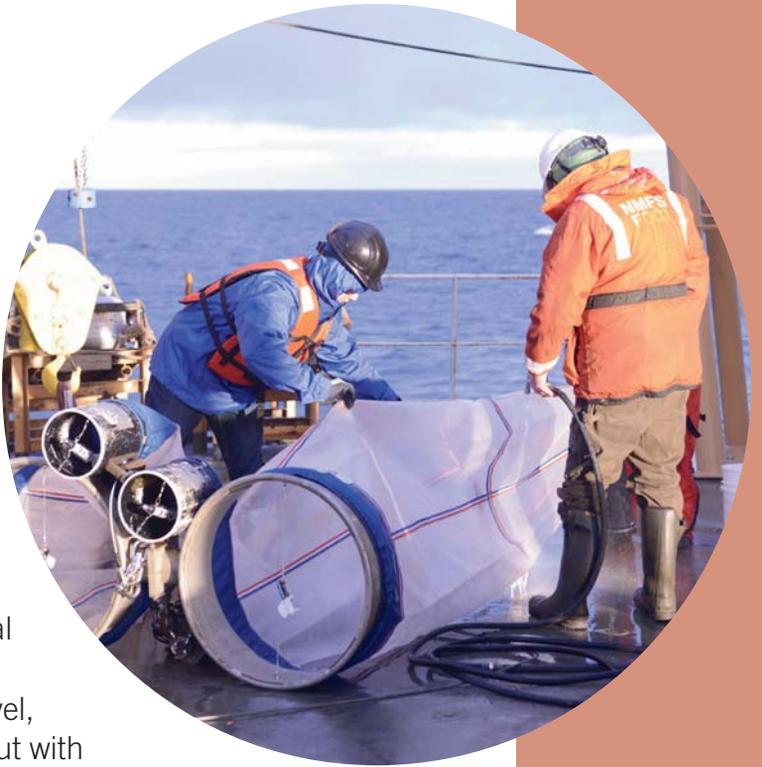*Chris Roper, Sales Manager for North America Saab Seaeye*

MATE Responds to Ocean Workforce Trends

MATE's research has identified a number of ocean workforce trends that have implications for the educational system. Marine technicians now deal with more computerized automation and remotely controlled systems (such as autonomous underwater vehicles, gliders, and drifters). They are installing, operating, and maintaining an ever-increasing number of sensors and managing greater volumes of data coming in more quickly. Marine technicians are not only delivering more real-time data, but they are also playing larger roles in creating data products to meet customers' needs.

As a result, students preparing for the ocean technical workforce need to be more versatile, adaptable, and interdisciplinary. They need to function at a higher level, be better communicators (not just with co-workers, but with customers who are increasingly international), and learn new technologies frequently.

Marine technicians prepare to deploy bongo nets.

MATE contributes to the workforce readiness of its students by instilling work-ready attitudes and relevant experience through its at-sea internship program, ROV competitions, and SeaMATE. In addition to employing community college students, SeaMATE promotes technical education through the sale of its ROV kits to the K-12 community.

SeaMATE ROV Kit Sales
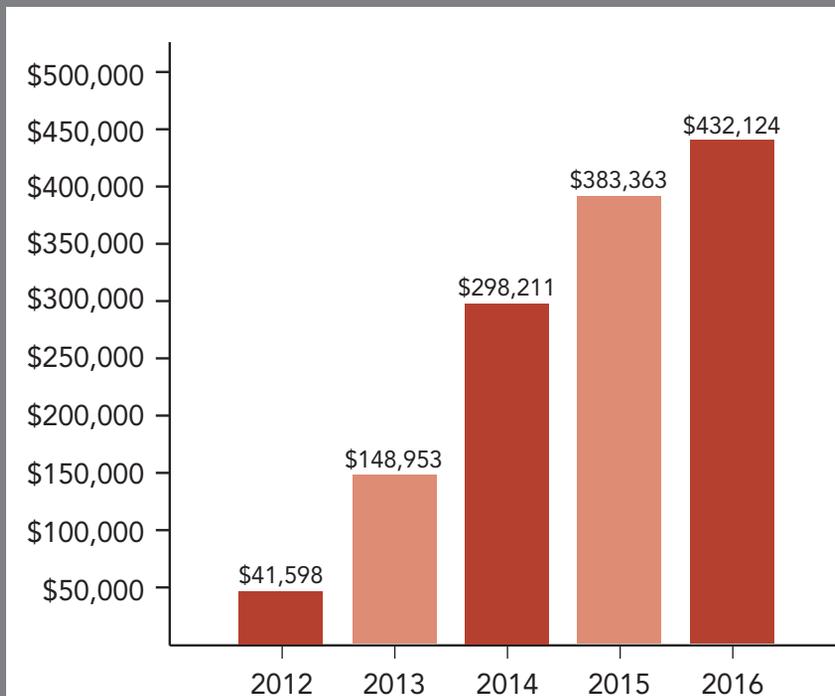
Sales of SeaMATE ROV kits, assembled by community college students, have increased as more schools engage in underwater robotics.

Year	Sales
2012	$41,598
2013	$148,953
2014	$298,211
2015	$383,363
2016	$432,124

MatEdU
National Resource Center
for Materials Technology Education

Edmonds Community College, Lynnwood, WA
http://www.materialseducation.org

National Resource Center
www.materialseducation.org

MatEdU Keeps Educators Current & Engages Students with Innovative Programs

With rapid changes and developments in nanotechnology, bioscience, and corrosion, as well as in more traditional areas of metals, plastics, and composites, industry's need for qualified technicians who understand the basics of materials technology has grown exponentially.

MatEdU is focused on the critical task of educating skilled technicians. It is the trusted resource that educational and training programs access to stay current, as well as to identify and articulate the linkages between materials science and manufacturing processes.

Composites 101 and STEM Guitar Project workshops for students in grades 8-12 are two examples of MatEdU partnerships that promote student engagement in materials science through innovative learning opportunities.

Key Activities
• Offers a digital collection of high-quality resources and classroom-ready modules for materials science instruction.
• Expands professional development opportunities for secondary and postsecondary educators in multiple STEM disciplines.
• Leverages partnerships to prepare technicians to work with new and conventional materials.

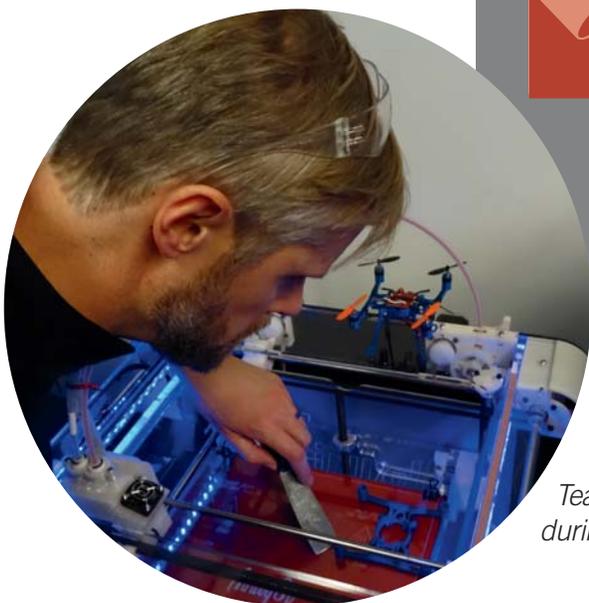*High school students learn about composites at a MatEdU program.*

MatEdU Helps Ensure US Competitiveness

MatEdU responds to the national need for state-of-the-art curricular and instructional resources in materials technology to strengthen the engineering and advanced manufacturing workforce. With program-appropriate modules, flexible delivery formats, and a validated set of core competencies in materials technology, MatEdU helps to enable and enhance technician education. This, in turn, helps ensure the US remains globally competitive in advanced materials and manufacturing technologies.

Strategic Partnerships Broaden MatEdU's Impact

Through the Washington State Department of Commerce, MatEdU connects strategically with policy makers on the state, national, and international levels. The work and contributions of MatEdU directly and positively impact educational programs on a national level through connections with partner two- and four-year institutions, high schools, skills centers, and industry. More than 100 educators a year are directly impacted by attending Materials in STEM, Guitar Building, or Additive Manufacturing workshops.

The ubiquity of materials led to MatEdU's extensive collaborations and partnerships with other ATE centers and projects. Through these relationships the center is broadening its impact by ensuring related programs have access to MatEdU's knowledge, resources, models, and best practices in materials science.

> *"I most liked learning about new materials technology and its role in the economy— and how educators can support students interested in the emerging fields associated with it."*
>
> *Cathy Webb, Instructor*
> *Edmonds School District*

Most Downloaded Resources from MatEdU

- *Materials Science Handbook*
- *Material Science Core Competencies*
- Materials Science Frameworks
- Partner Spotlights

MatEdU's website had 61,746 visitors in the 2016-2017 academic year, and the *Materials Science Handbook* was the most popular download.

Teachers make drones using 3-D printers during MatEdU's summer workshops.

MPEC
Midwest Photonics Education Center

Indian Hills Community College, Ottumwa, IA
http://midwestphotonics.org

MPEC Kits Infuse Photonics in Courses

MPEC helps community colleges and high schools infuse photonics education into their existing programs through the use of portable photonics kits for hands-on laboratory activities. The MPEC Photonics Kits have enough industrial grade equipment and components to allow students to perform up to 30 individual laboratory activities.

The center's activities have led to productive interactions with educators in its nine-state Midwest service region and beyond. For instance, it helped Anoka-Ramsey Community College (MN) and Minnesota State College Southeast add photonics to their existing biomedical and electronics programs, respectively. Both colleges sought MPEC's assistance to address local employers' needs for technicians with photonics skills.

Key Activities
- Provides photonics workshops for students and educators.
- Offers symposia for technicians, students, and educators.
- Coordinates student internships, job shadowing, co-op programs, company tours, and field experiences.
- Helps colleges and schools plan labs and select equipment.

"During our company's 25 years of existence, we have hired 34 graduates of the Indian Hills Community College (IHCC) Laser and Optics Technology program. The education and training provided by IHCC meets the requirements of our technical workforce. The IHCC graduates have contributed greatly within our organization."

Dennis Lockwood, Project Manager of Technical Services
Northrop Grumman, Cutting Edge Optronics
1989 IHCC Laser & Optics
Technology Program Graduate

MPEC's curriculum teaches students how to combine three colors of light to produce white light.

Closer Work with Employers Changes Hiring Patterns

Since 2014, MPEC has been expanding to address advanced manufacturers' technician needs. It has worked with a network of six educational institutions in nine Midwest states to provide faculty professional development.

MPEC has increased the number and enhanced the skills of people pursuing photonics careers. In Iowa, Ohio, Illinois, Kansas, Missouri, Minnesota, and Michigan, 174 MPEC students completed photonics courses in 2017 compared to 64 in 2014. This has begun to change hiring patterns. In the past many employers relied on electronics technicians whom they trained in-house or sent to short-term programs to carry out photonics tasks. Now companies offer paid internships to students and full-time jobs to program completers.

MPEC facilitates students' internships by identifying and posting positions. The center also encourages photonics professionals to speak in classes, participate in outreach programs, and conduct preliminary employment interviews on campus.

Job placement of photonics graduates from Indian Hills Community College (IHCC) has been nearly 100% every year. Twenty-six companies from across the nation have hired its graduates since 2014. The entry-level salary for graduates of MPEC-affiliated photonics programs in 2015-2017 ranged from $37,440 to $70,000; their average salary was $50,216.

An Indian Hills Community College alumnus sets up a CO_2 laser engraving system at Preco, Inc.

Photonics Graduate Job Placement Rates

Year	Placement Rate	Ratio
2014	94.1 %	16:17
2015	95.5 %	21:22
2016	93.8 %	15:16
2017	100%	12:12

Graduates Enter Workforce Immediately
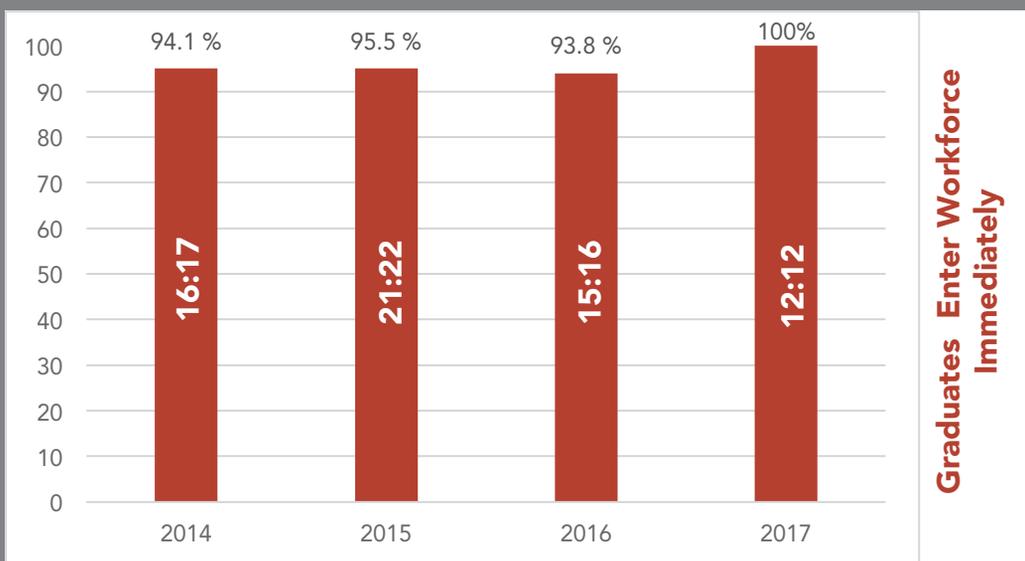
With 64 of it 67 graduates immediately entering the workforce, the photonics program at Indian Hills Community College had an average job placement rate of 95.5% from 2014 through 2017.

OP-TEC
National Center for Optics and Photonics Education

OP-TEC, Waco, TX
http://op-tec.org

OP-TEC Shines Light on Optics & Photonics Careers

Plentiful opportunities for rewarding careers are available to graduates of photonics associate degree programs. Technicians from these programs have the competencies to operate and maintain lasers, optics, and photonics devices, and to integrate them into larger systems in industries where photonics is an enabling technology.

OP-TEC and more than 30 college partners provide pathways to successful careers for high school students and adults with an emphasis on outreach to women, minorities, and veterans.

Key Activities
- Develops and disseminates teaching materials.
- Shares successful methods for student recruiting and retention.
- Provides improvement and safety guidance for laboratories.
- Identifies and supports teaching of emerging technologies.
- Provides professional development for faculty and employed technicians.

OP-TEC teaching materials, planning guides, and reports on successful practices prepare faculty to adapt as technologies and learners' needs change. These OP-TEC resources have influenced increases in student persistence and completion rates.

Hands-on laboratory work is essential to laser, optics, and photonics student success.

Photonics technician education opens career paths in many industries.

OP-TEC Leads Photonics Technician Education

OP-TEC has led the growth of photonics programs at US colleges, from 15 in 2007 to 36 in 2017. It has also helped nine colleges obtain NSF ATE grants and assisted with the reinstatement of photonics programs at seven colleges.

The disparity between employer demand and the inadequate supply of qualified photonics technicians is critical. To meet this need, OP-TEC continues its work to advance the capacity of photonics and photonic-enabled technician education programs through information dissemination, distribution of materials, employer partnerships, and outreach to students.

OP-TEC has developed the tools that are needed by colleges and faculty to teach photonics. These tools include three sets of skill standards, modular lab-based teaching materials, video tutorials, animated graphics, math supplements, curriculum and program planning guides, online professional development, and reports describing best practices for student recruitment and retention.

Collaboration with alumni and student recruiters has yielded customizable outreach materials intended to raise awareness and change student and parent perceptions about photonics careers. These resources are provided through OP-TEC's dynamic website, monthly electronic newsletter, email, and social media.

"Industry's demand for photonics technicians far exceeds the supply. Lawrence Livermore National Laboratory's Laser Division alone employs over 130 photonics technicians and the need continues to grow. OP-TEC has served as my initial point of contact for every photonics technician education program I've visited."

Ron Darbee, Engineering Superintendent of Laser Systems Engineering & Operations, Lawrence Livermore National Laboratory

Worldwide Laser Sales

Year	Sales
2013	$8.9 B
2014	$9.4 B
2015	$9.7 B
2016	$10.4 B
2017	$12.4 B
2018	$13.0 B (forecast)
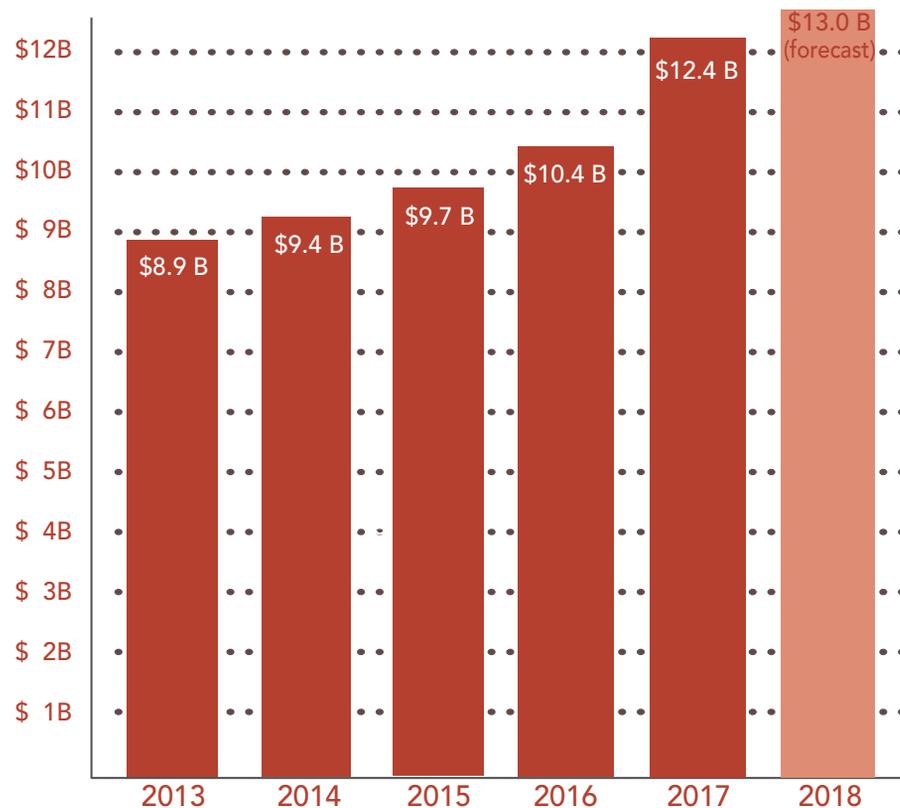
Photonics technician opportunities grow with laser sales. (Figures in billions of US dollars.) Source: Strategies Unlimited

SCA
National Center for Supply Chain Automation

Norco College, Norco, CA
http://www.supplychainautomation.com

National Center for Supply Chain Automation
RESOURCES FOR EDUCATION & INDUSTRY

SCA Boosts Supply Chain Careers & Collaborations

SCA informs the public and increases the visibility of the high-growth career opportunities that are available in many different industries for supply chain technicians. These are the people who install, operate, support, upgrade, or maintain automated material-handling equipment and systems.

SCA recognizes the critical importance of industry-education partnerships in developing technicians for enterprises that move, store, or deliver products. To support these partnerships, SCA convenes stakeholders in targeted locales and educates them on the many ways they can collaborate to support the development of a highly skilled supply chain technician workforce.

Key Activities
• Supports supply chain automation pathways at US educational institutions.
• Convenes industry-education forums to facilitate partnerships that help students become supply chain technicians.
• Enhances collaborations with national symposiums.
• Establishes and promotes industry certification of supply chain technicians.

A supply chain technician repairs a conveyor belt that moves small, light products.

Classroom conveyors allow students to work on miniature versions of supply chain systems.

SCA Helps Colleges Grow Supply Chain Workforce

There are expected to be 770,000 job openings in the US for supply chain technicians through 2025. Annual wages range from $35,000 to $58,000; technicians with advanced work experience earn about $87,000.

To increase the number of highly qualified supply chain technicians, SCA helps educational institutions across the US establish programs by providing instructional resources and technical assistance to them at no cost.

SCA's resources include the e-textbook *Introduction to the Automated Warehouse*. It covers all the skill sets that supply chain technicians must possess to be successful in an automated warehouse. It utilizes videos, puzzles, games, illustrations, and interactive widgets to engage students while delivering the material in a way that is fun and easy to understand.

This e-textbook is available for download from the Apple iBooks Store or in PDF format on the center's website.

Industry certifications represent the gold standard for validating the competencies. Consequently, SCA has partnered with the Manufacturing Skill Standards Council and MHI to establish a new certification, which is tentatively titled "Certified Technician in Supply Chain Automation."

"Employment as a supply chain technician is one of the best opportunities for individuals to earn a living wage without an advanced degree. Those who enjoy working with their hands and demand a great deal of variety in their day-to-day work are most suited to this work."

Steve Harrington, Chairman
Distribution Management Association of Southern California

Supply Chain Occupations with the Most Job Openings

Supply Chain Occupations	Jobs in 2015	Anticipated Additional Job Openings by 2025
Maintenance & Repair Workers	1,442,793	435,504
Industrial Machinery Mechanics	338,283	171,495
Installation, Maintenance, and All Other Repair Workers	179,378	47,685
Electrical & Electronics Engineering Technicians	141,836	37,248

Most of the 770,000 new and replacement jobs in the supply chain technical workforce are expected in four occupations through 2025.

SMART
Southeast Maritime
and Transportation Center

Tidewater Community College, Virginia Beach, VA
http://maritime-technology.org

## Marine Technology Pathway Attracts Students

Since SMART's inception in 2010, enrollment in its Maritime Technologies Pathway courses almost doubled for minorities, women, veterans, and first-generation college students at its three partner colleges.

Nearly 500 students have graduated from six Houston maritime academy high school programs created by San Jacinto College (TX), a SMART partner college, and the Port of Houston. An additional 1,200 high school students enrolled in 2017-18.

San Jacinto College also graduated its first class of 33 associate in applied science degree mariner pathway students in 2017. Enrollment in the college's marine technologies program nearly tripled, increasing from 25 students in 2016 to 72 student in 2017.

Key Activities

- Fosters synergistic partnerships between industry, educators, and community colleges.
- Consolidates education criteria for specific maritime occupations.
- Develops SMART career pathways and education programs.
- Facilitates portable credentials.
- Promotes awareness of maritime, transportation, and logistics careers among students, parents, and educators.
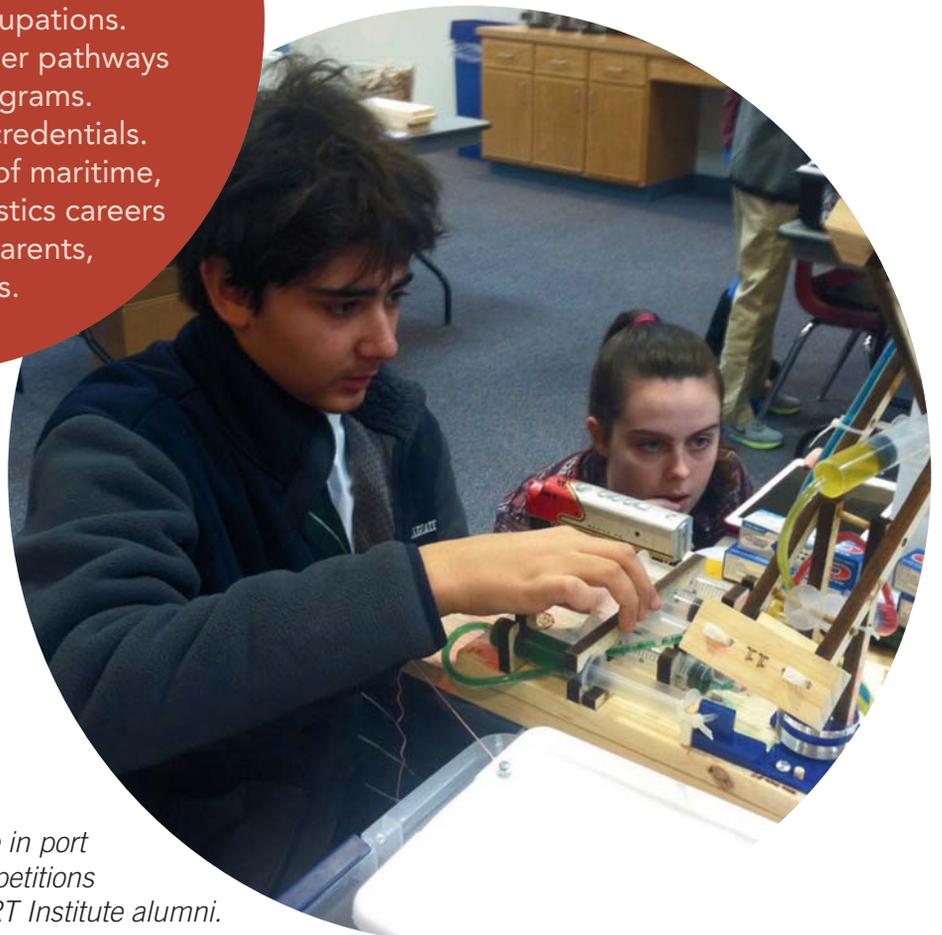
Students participate in port crane building competitions developed by SMART Institute alumni.

SMART Influences Educators

SMART produced a first-of-its-kind *Maritime and Transportation Career Guide & Educators' Resource Guide*, which includes eight new "Make the SMART Choice" videos. The center distributed 3,400 copies of the guide and videos to career coaches, guidance counselors, and STEM educators.

More than 50 educators and industry outreach professionals have attended Annual SMART Maritime and Transportation Institutes and new Get SMART workshops. During 2016-2017 these participants produced

- 16 new classroom modules; and
- 13 new maritime-related courses for secondary or postsecondary programs, or curricula modifications.

Altogether the educators have reported that 1,325 students have enrolled in maritime-related courses or programs due to information they were able to share in classrooms as a result of their institute participation.

Port Workforce Needs Identified

Through two, two-day focus groups held in conjunction with the Port of Baltimore and the Port of Houston, SMART produced the first-ever industry-validated surveys of critical workforce, skill, and credentialing needs for ports and port-connected employers. SMART will use this information to help educators develop vital career pathways and curricula in this essential maritime sector.

"There are so many opportunities in the industry [of which] students are totally unaware. So when I come to a SMART Institute, I begin to learn how to turn everything that is going on in the industry into a usable product in the classroom for the teachers."

Jamie Meyer, High School Teacher & Train-the-Trainer Specialist SMART Institute Alumnus

A second mate on a MARAD vessel manually plots a course using skills he learned at a maritime academy.

Marine Technologies Pathway Course Enrollments			
	# of enrollments		
	2015-2016	2016-2017	Change
Females	99	202	+103
High school dual enrollment	57	127	+70
Minorities	256	316	+60

SMART Center's recruitment of women, high school students, and minorities to pursue maritime technology careers yields positive enrollment results.

SpaceTEC
National Resource Center for Aerospace Technical Education

Eastern Florida State College, Cape Canaveral, FL
http://spacetec.org

Soldier for Life Re-ups with SpaceTEC

SpaceTEC Partners Inc., through its Cert*TEC®* division, supports the US Army's Soldier for Life Credentialing, Education and Alumni Working Group. Cert*TEC* credentials support ordnance electronics maintenance training of soldiers at three locations: Fort Lee, VA; Fort Gordon, GA; and Fort Sill, OK. Program exams lead to performance-based certification in basic electricity and electronics (BEE), which count toward service members' promotion points.

The Soldier for Life program leverages service members' military training and experience for civilian careers. SpaceTEC's credentialing improves individuals' job prospects and helps reduce the Army's unemployment compensation costs.

Key Activities
- Offers FAA-endorsed Certified Aerospace Technician certification.
- Partners with ASTM International on an aviation technician certificate.
- Administers performance-based certifications for civilian and military aerospace technicians.
- Provides K-12 Schools to Space program in 3 states.

An aviation sheet metal instructor and a student demonstrate team bucking for rivet installation at Francis Tuttle Technology Center.

The MakerTEC® Coordination Network, an ATE project, works with SpaceTEC to expand the use of the aerospace technician curricula in other fields.

Partnership with ASTM International Moves SpaceTEC into Aviation Technology

In 2017, SpaceTEC and ASTM International created a formal partnership to address the aviation industry's need for a national credentialing process for aircraft maintenance technicians and aviation operations personnel.

ASTM International is responsible for the development and management of more than 12,000 standards used internationally by governments, industries, and institutions. In 2014, ASTM International absorbed the aviation technician certification products that the National Center for Aerospace and Transportation Technologies (NCATT) developed with multiple ATE project grants.

With the 2017 memorandum of understanding between SpaceTEC and ASTM International, SpaceTEC became the administrator for all ASTM-NCATT written exams. This is in addition to its administration of other job-oriented knowledge and practical-skill certification examinations. SpaceTEC also processes applications from schools and industry training providers for ASTM-NCATT Training Provider accreditation.

This full complement of certifications has the potential to help graduates of the 170 US colleges with avionics programs provide employers with objective evidence of their practical knowledge and skills. With the addition of ASTM-NCATT training providers to the existing SpaceTEC Partners Inc. sites, there are now more than 50 SpaceTEC-ASTM approved training providers and testing centers nationwide.

"The need for high-quality standards that help train workers in this dynamic global industry is clear. ...This is a smart partnership that will help address this pressing societal need."

Katharine Morgan, President
ASTM International

Basic Electricity and Electronics (BEE) Certifications Awarded

901
(In 2017)

3,869
(Since 2011)

As more military bases offer technicians the BEE exam at the end of their training, Cert*TEC*'s awarding of certifications continues to increase. The certificate counts toward soldiers' and sailors' promotion points.

Flipped-Classroom Resources for Electrical Engineering Technicians

Columbia Gorge Community College, The Dalles, OR
http://ate.is/DDFC

Project's Lessons Attract Viewers to BigBadTech YouTube Channel

BigBadTech videos and other project materials support flipped-classroom instruction for teaching technical subjects like electronics, motor control, hydraulics, and pneumatics.

The flipped-classroom approach delivers instruction outside the classroom and activity-based learning inside it. The approach reduces students' textbook and commuting expenses and provides them with more flexibility for balancing college, work, and family responsibilities.

Students view free online lectures at the time and place of their choosing and at their own pace. This allows students to pause, rewind, and review material as necessary. Concept engagement and application happen in the classroom with an instructor's guidance.

BigBadTech YouTube Channel Data July 2016 to March 2018

1,600
average daily views

15,000
subscribers

1.2 million
total views

Viewership for flipped-classroom resources on the project's BigBadTech YouTube channel continues to grow.

Engineering Technology Challenge

Manchester Community College, Manchester, CT
http://ate.is/ETC

Teens Learn Professional & 3-D Tech Skills

The Engineering Technology Challenge Program (ETC) teaches inner-city and underrepresented students professional skills, such as teamwork, as they learn technical skills related to 3-D printing. Technical writing and additional physics and technology labs enhance students' abilities to apply what they have learned during the six Saturday programs at community colleges.

The high school students also interact with college students who share their personal experiences as people in underrepresented populations preparing to become technicians.

Several high school principals report that after ETC, their students' attendance and grades improved and the teens seemed more self-assured and excited about pursuing STEM careers.

Inner city youths learn about 3-D printing and professional skills during Engineering Technology Challenge programs.

Introduction to Coding, Robotics, Electronics, And Technology (iCREAT)

MassBay Community College, Wellesley Hills, MA
http://ate.is/iCREAT

Robot Creation Involves Multiple Disciplines & Workforce Skills

The iCREAT project introduces high school students, mostly from populations underrepresented in STEM, to computer science and engineering topics through two interdisciplinary credit-bearing courses.

Students focus on creating micromouse robots in the first course and telepresence robots in the second course during the four-week summer sessions. Students who successfully complete the first course may take the second course the following summer.

These hands-on project-based courses integrate 21st century workforce skills such as teamwork with lessons in design processes, electronics, engineering, coding, networking, and cybersecurity.

Students are also matched with mentors from similar backgrounds to provide online mentoring while exploring relevant STEM careers.

iCREAT participants work in teams to solve issues that occur as they build robots.

SFAz+8: Building Capacity for STEM Pathways in Rural Arizona

Science Foundation Arizona, Scottsdale, AZ
http://sfaz.org/sfaz8

SFAz+8 Builds Rural Students' Interest in STEM

The SFAz+8 collaborative of eight rural Arizona community colleges and Science Foundation Arizona (SFAz) is improving the STEM student pipeline with outreach activities, summer camps, early college programs, internships for students, workshops for K-12 teachers, and program delivery with shared faculty.

The colleges use common STEM metrics and data collection methods and have aligned their activities with SFAz's STEM Pathways Model.

From 2015-2016 to 2016-2017
- early college completions increased 32% from 1,438 to 1,895;
- internships increased 28% from 147 to 188;
- engineering associate degree completions increased 44% from 63 to 91; and
- engineering certificate completions increased 60% from 254 to 407.

A Summer Science Camp at Arizona Western College introduced rural middle school students to chemistry principles with discovery-based lab activities.

General Advanced Technological Education

http://ate.is/gen

General

ATE Central: Supporting Advanced Technological Education

ATEC**ENTRAL**

Internet Scout Research Group, University of Wisconsin - Madison, WI
http://atecentral.net

ATE Central Fosters Collaboration & Communication

ATE Central's online portal, tools, and technologies are designed to encourage and facilitate data sharing, communication, and collaboration.

ATE principal investigators and teams have a host of experience and expertise to offer each other and those outside the community. ATE Central creates pathways to this expertise that help principal investigators and staffers at ATE projects and centers connect, collaborate, and build on each other's knowledge and reach other audiences. Diverse stakeholders take advantage of the services and resources offered by ATE Central to share information, find collaborators, access and utilize valuable materials, and engage with ATE projects and centers.

Key Activities

• Sustains and promotes use of ATE deliverables through digital archive.
• Cultivates collaboration and information sharing through a centralized online hub.
• Provides tools and services that support ATE community activities.
• Promotes use of best practices through workshops, webinars, and publications.

"The Center for Curriculum Redesign wanted to work with ATE grantees and looked to ATE Central to facilitate an introduction. Without this sort of centralized organization that cuts across all projects and centers, the resulting collaboration wouldn't have been possible."

Merrilea Mayo, Founder
Mayo Enterprises

ATE Central provides access to curricula and other materials developed by ATE grantees, such as the BEST Center, that can be freely adapted and adopted by educators.

ATE Central Helps Broaden & Sustain Impacts

Sustaining access to the collective work of the ATE program is critical. While individual projects and centers may not persist, access to their deliverables, data, and outcomes should. To ensure these valuable resources stay available, ATE Central provides an archiving service and ongoing support to the ATE community. Now an ATE requirement for grantees, the archiving service is streamlined and supported by online templates, reference materials, workshops, and webinars.

In tandem with archiving, ATE Central also supports grantee efforts to sustain their work through targeted activities and online resources including a series of videos created in collaboration with the American Association of Community Colleges. The videos feature interviews with experts from within and beyond ATE and provide practical advice about sustaining access to project and center deliverables.

Broadening access and making resources and activities accessible at all levels and for all users, including those with disabilities, are of paramount importance to ATE Central. That is why the project utilizes and promotes the use of universal design practices for the ATE community through workshops, webinars, and online resources.
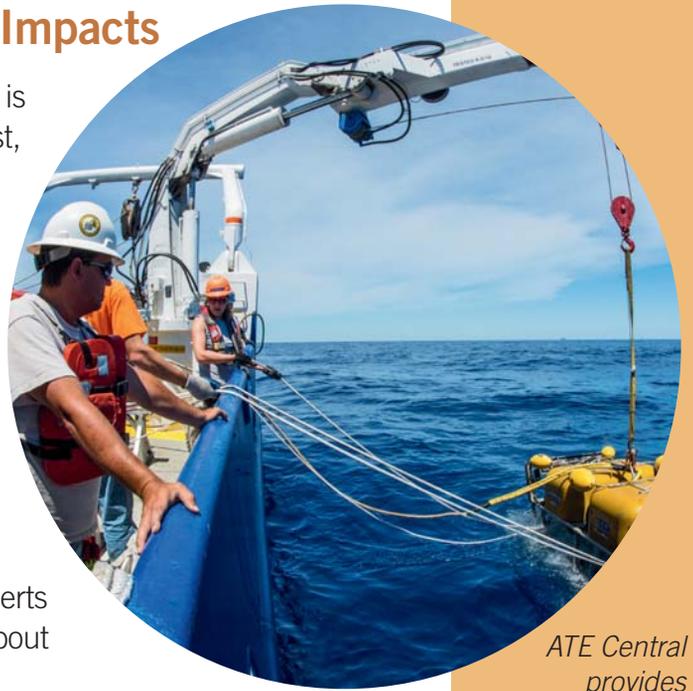
ATE Central provides instruction and resources to help grantees sustain their NSF deliverables, like the valuable materials created by the MATE Center.

ATE Central Usage Grows

Unique Visitors

140,000

120,000 — 117,441

100,000

80,000

60,000 — 58,686

40,000

29,179

20,000

334

0

2008   2011   2015   2017
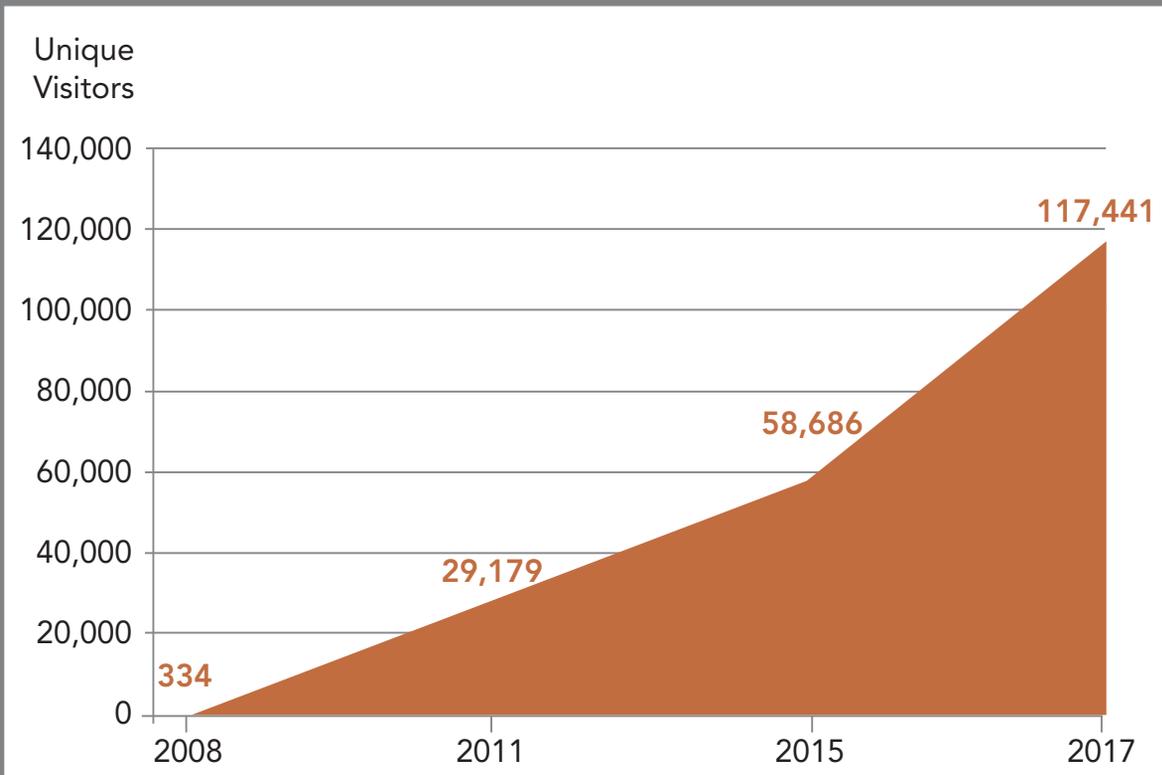
Use of ATE Central's online portal has grown significantly from 334 unique visitors in 2008, the year the project launched, to 117,441 in 2017.

DeafTEC
Technological Education Center for Deaf and Hard-of-Hearing Students

Rochester Institute of Technology, Rochester, NY
http://deaftec.org

DeafTEC Improves Classroom Instruction

More than 60 partner educators received instruction at DeafTEC professional development workshops and then offered those workshops in California, Florida, Illinois, and Texas to more than 2,000 high school and community college educators. The workshops focus on best practices and materials for teaching deaf and hard-of-hearing (deaf/hh) students, improving pedagogy for all students, supporting math instruction, and incorporating more writing in STEM classes.

In follow-up surveys on their "Plans for Change," educators reported that DeafTEC's practical strategies were easy to implement and benefited not just deaf/hh students, but all students. They also reported that they felt more connected with deaf students and more confident in meeting the needs of all students.

Key Activities
- Provides professional development.
- Shares best practices online.
- Leads a national STEM dual-credit program.
- Offers STEM camps and activities.
- Provides resources for teaching student veterans with hearing loss.
- Maintains an online STEM American Sign Language Video Dictionary.

Deaf high school students learn about careers in manufacturing.

DeafTEC Facilitates Inclusive Workplaces

More than 500 employees from DeafTEC's industry partners have attended workshops on how deaf and hearing people can successfully work together in an inclusive workplace. DeafTEC's partners have also developed training and internship opportunities to help deaf and hard-of-hearing students transition from school to work.

In follow-up surveys on their "Plans for Change," the employees who attended DeafTEC's workshops reported that they now communicate more effectively with deaf colleagues, that deaf and hard-of-hearing employees are more engaged with colleagues, and that hearing individuals had taken the opportunity to learn more about the deaf culture.

New Online Course Informs Employers across US

A new five-module online course makes interactive lessons from DeafTEC's Working Together: Deaf and Hearing People workshops available for free to employers who cannot attend DeafTEC's in-person programs.

DeafTEC Shares Veterans' Advice

Information from focus groups with student veterans with hearing loss resulted in *Top Ten Things Student Veterans Would Like Faculty to Know*. This document helps faculty understand military culture and the veteran transition experience. It also provides teaching strategies that improve access to learning for all student veterans.

"Through the Working Together: Deaf and Hearing People workshop, Lockheed Martin employees have increased awareness and understanding to better accommodate the needs of their deaf and hard-of-hearing coworkers."

Marina Williams, Director of Equal Employment Opportunity Programs Lockheed Martin

EMPLOYER & EDUCATOR WORKSHOP OUTCOMES

Positive outcomes reported by 33 employers and 255 educators more than six months after attending a DeafTEC workshop include the following:

EMPLOYER OUTCOMES

76% CHANGED WORKPLACE BEHAVIORS

52% INCREASED ENGAGEMENT WITH DEAF/HH CO-WORKERS

48% CHANGED THEIR ATTITUDES ABOUT WORKING WITH DEAF/HH CO-WORKERS

EDUCATOR OUTCOMES

59% INCREASED STUDENT ENGAGEMENT

48% CHANGED THEIR TEACHING BEHAVIORS

43% IMPROVED TEACHING EFFECTIVENESS

A machining technology student, who is deaf, operates a CNC function on a vertical mill.

EvaluATE
Evaluation Support Center for Advanced Technological Education

Western Michigan University, Kalamazoo, MI
http://evalu-ate.org

EvaluATE Helps ATE Projects & Centers Enhance Their Impact

EvaluATE provides instruction and resource materials to help ATE community members, including principal investigators, project staff, evaluators, and grants specialists develop their capacity to conduct evaluations of their NSF-funded work, especially measuring their impact on students. Sound evaluation enhances grantees' accountability to NSF. It also provides evidence of the quality and effectiveness of ATE projects and center efforts. Most importantly, projects and centers use their evaluation results to identify ways to improve their work and thereby enhance their impact on students. In 2017, 90% of the 186 ATE principal investigators who responded to survey questions about evaluations reported using evaluation findings to modify their activities.

Key Activities
- Educates the ATE community and others about evaluation.
- Supports the ATE evaluation community.
- Shares best practices and real-world lessons learned.
- Collects and reports data on ATE program activities and accomplishments.

Formative evaluations help the MakerTEC® Coordination Network improve community colleges' talent pipeline.

Faculty who attend Build Your Own Video workshops complete surveys that provide data on the tool's use for student recruitment.

Webinars, Blogs & Other Resources Strengthen ATE Community's Evaluations

EvaluATE's webinars continue to grow in popularity and are consequently strengthening the evaluation knowledge and skills of ATE community members and others. Attendance at EvaluATE's webinars increased by 900 participants from 2014-15 to 2015-16. The step-by-step guidance on evaluation provided by EvaluATE's personnel attracted 1,293 participants in 2015-16. Attendance continues to grow within and beyond the ATE community.

EvaluATE's biweekly blog supports peer-to-peer learning. Readers learn from the real-world stories of ATE colleagues and from the first-hand accounts of emerging theories and methods for STEM education evaluation. Topics are diverse, addressing issues such as evaluator-client relationships, student assessment, innovative techniques for data collection and analysis, logic models, and evaluation reporting.

EvaluATE's quarterly newsletter points readers to resources for enhancing their evaluation practices related to developing evaluation plans, collecting and analyzing data, and reporting evaluation results.

EvaluATE's digital library contains a variety of materials key to specific evaluation tasks. Examples include checklists for developing ATE evaluation plans and reports, templates for data collection planning and logic models, and a how-to guide for finding and selecting an evaluator.

"Since EvaluATE's inception, there has been a dramatic shift in the way members of the ATE community view evaluation. This movement has been from evaluation as obligation to evaluation as a valuable and worthwhile process."

Peggie Weeks, ATE Evaluator
Lamoka Educational Consulting

EvaluATE Webinar Participation

Year	Attendees
2015-2016	1,293
2014-2015	393
2013-2014	405
2012-2013	366

Attendees
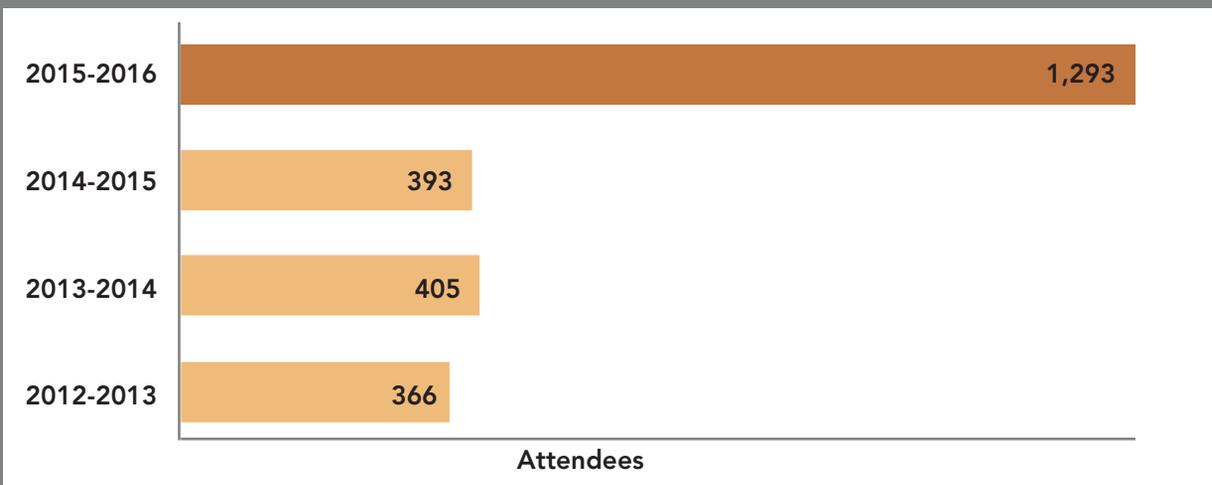
EvaluATE's practical guidance on evaluation attracts attention within and beyond the ATE community.

SCATE
South Carolina Advanced Technological Education Center of Excellence

Florence-Darlington Technical College, Florence, SC
http://scate.org

SCATE Resources Facilitate Innovations

Through its wide connections SCATE has been impacting student success since 1995 by providing resources that lead to innovative solutions for expanding excellence in technician education regionally and nationally.

SCATE works directly with its Industry Consortium on paid internships for engineering technology students. This program helps to close the digital divide among underrepresented populations and stimulates on-time degree completion. The 108 recipients of NSF S-STEM Scholarships since 2013 have a graduation rate of 70%.

SCATE's http://TeachingTechnicians.org is the nation's only online service that proactively connects the educators of technicians to relevant professional development. More than 3,000 registered users and others utilize it.

Key Activities
- Leads innovative STEM faculty mentoring program.
- Provides unique technician education compendium of research.
- Develops and implements successful student recruitment and retention strategies.
- Fosters partnerships between educators, employers, and organizations.
- Connects STEM faculty with professional development.

"Just want you to know … that your Mentor-Connect project spread wonderful seeds of scholarship for our faculty and colleges, which are paying dividends by impacting our students."

Christine Johnson, Chancellor Community Colleges of Spokane

SCATE's curriculum uses a just-in-time format that mimics workplace tasks.

BYO Video Tool & Mentor-Connect Address Colleges' Needs

SCATE's many resources to support the preparation of a highly skilled technician workforce in engineering, manufacturing, and industrial technologies include an innovative student recruitment tool that is available for free to individuals and colleges, and mentoring and technical assistance to help faculty prepare competitive STEM grant applications.

The Build Your Own (BYO) video tool provides access to a searchable collection of professionally produced STEM videos that have been micro-segmented for faculty and college staff members to access online to create customized STEM program recruitment videos.

SCATE's Mentor-Connect project provides a multi-faceted process for sharing knowledge to help STEM faculty develop grant-writing and leadership skills.

While providing one-on-one mentoring to selected faculty teams as they prepare proposals for the NSF Small Grants for Institutions New to ATE funding track, Mentor-Connect activities cultivate a new generation of community college STEM leaders. Through 2017, the project assisted 101 colleges with more than 64% of them receiving NSF awards. Free resources that Mentor-Connect offers to the public include technical assistance from its help desk and 200 digital materials, including articles and webinars that provide grant-writing advice.

Through Mentor-Connect, SCATE helps colleges bring populations underrepresented in STEM fields into the technical workforce.

SCATE Impact on STEM Faculty & Students

TeachingTechnicians.org
3,100 Users

Mentor-Connect
101 New-to-ATE Colleges Served

Compendium of Research
400+ Technician Education Publications

108 S-STEM Scholarship Recipients
70% Graduation Rate

SCATE resources help develop highly skilled technicians in engineering, manufacturing, and industrial technologies.

Adapting Tested Spatial Skills Curriculum to Online Format for Community College Instruction

Stevens Institute of Technology, Hoboken, NJ
http://ate.is/SKIITS

Stronger Spatial Visualization Skills Result in Better Tech Course Grades

To improve community college students' spatial visualization skills, which researchers have identified as critical to success in STEM courses, the project modified the 10-module Developing Spatial Thinking (DST) curriculum for use online. Four community colleges delivered the course; two also used the project's iPad drawing app.

The scores of 485 eligible students on the *Purdue Spatial Visualization Test: Rotations* were significantly higher for students who completed the DST curriculum.

Most importantly, students who completed the DST curriculum earned higher grades in technical education courses than students who were eligible but did not participate in the course.

Students practice spatial skills using sketching exercises and snap cubes from the Developing Spatial Thinking curriculum.

Contextualizing Career Technical Education in Math

Rogue Community College, Medford, OR
http://ate.is/CCTEM

Students Who Learn Math in Context Do Well in Subsequent Courses

Rogue Community College faculty used an ATE grant to develop two applied algebra courses that use genuine, technical workplace problems. The results are promising.

Students are passing Applied Algebra 1 and 2 courses at a higher rate than students in the college's traditional math track. Most significantly, Applied Algebra 2 students perform well in a subsequent statistics course without the additional course required in the traditional math track.

At the project's free summer institutes, high school and community college educators gain a richer understanding of algebra's real-world uses by measuring beams, building circuits, and checking amperages. They also learn how to launch the contextualized courses at their institutions.

Summer math institute participants apply the Pythagorean Theorem to a concrete-forming problem.

Mt. SAC STEM Teacher Preparation Program (STEM TP2)

Mt. San Antonio College (Mt. SAC), Walnut, CA
http://mtsac.edu/stemtp2

Multi-faceted Program Puts Students on STEM Teaching Path

The Mt. SAC STEM Teacher Preparation Program offers STEM majors the opportunity to cross-enroll in Introduction to Science and Math Teaching and Introduction to Research Methods at the University of California Irvine. In the first course, students learn content delivery, pedagogy, classroom management, and conduct fieldwork. In the second course, they learn research methodologies.

During the first summer these future teachers assist faculty in teaching middle school students at a Summer Science Camp. The second summer, they have the opportunity to conduct original research.

By December 2017, 19 of 24 students had transferred to complete their STEM degrees and pursue their teaching credentials.

Middle school students in Mt. SAC's Summer Science Exploration Experience measure $CaCl_2$ to determine the heat of a solution.

Skilled Workers Get Jobs 2.0: Appalachian Impact

Asheville-Buncombe Technical Community College, Asheville, NC
http://ate.is/SSGJ

Project Increases Female Enrollment

The project has implemented strategies for recruiting and retaining females in advanced technology programs at seven Southern Appalachian partner colleges.

More than 1,300 people—students and educators at various levels—have learned innovative ways to recruit and retain women in STEM tech fields through the project's workshops and presentations. These strategies to narrow the gender equity enrollment and persistence gap among female college students were developed with a previous ATE grant.

In addition to increasing female enrollment at six of the seven partner colleges, the use of problem-based learning has improved male and female students' attainment of course objectives.

Students complete a problem-based learning activity at a Women in Technology meeting.

Information and Security Technologies

http://ate.is/info

Info

BATEC
Broadening Advanced Technological Education Connections

University of Massachusetts Boston, Boston, MA
http://batec.org

BATEC Programs Enroll Many Minority Students

BATEC's collaboration with 23 community colleges and two high school districts led to increased enrollment in computing and information technology programs.

Enrollment in BATEC-affiliated community college degree programs increased from 11,429 students in 2012-2013 to 15,733 in 2016-2017. Course completions tripled at the high-school level, increasing from 1,700 in 2013 to 5,950 in 2017. In 2017, female enrollment was 47% in college programs and 42% at the secondary schools. Enrollment by underrepresented minorities was also significant. In 2017, the population of BATEC's community college participants was 23% Latino and 45% African American. Most of its high school students were either Latino or African American.

Key Activities
- Designs academic pathways in computing and information technologies.
- Publishes workforce trends with regard to career opportunities, compensation, and skill requirements.
- Integrates professional skills into traditional curricula.
- Conducts professional development in technical content and pedagogy.

BATEC's robotics curriculum teaches foundational computing concepts and basic programming skills.

Industry professionals mentor both teachers and students in professional skills, as well as technical skills.

Urban Academic Laboratory Aligns with Workforce Needs

BATEC functions as an urban laboratory that shares resources and subject-matter expertise between and among partner academic institutions. It offers academic and career pathways that facilitate students' progress from high school and community college classrooms to internships, first jobs, and lifelong careers.

BATEC has designed and implemented interventions aimed at creating and improving academic pathways to ensure they align with workforce needs. Its efforts are aided by local employers who provide guidance to faculty, as well as mentoring and internships for students.

The center has also defined new degree programs, incorporated emerging technologies into existing programs, integrated authentic workforce-based problems and exercises into course materials, and incorporated learning outcomes based on 21st century professional and soft skills.

"BATEC provides a venue for us to voice our opinions, discuss industry trends, and address the needs for our technology workers. Our partnership brings together stakeholders in IT, security, and big data to broaden the workforce and better prepare employees for the future."

*Tom Hopcroft, President and CEO
Massachusetts Technology
Leadership Council*

Institute Participants Teach 14,000 Students Annually

The BATEC National Summer Institute offers educators week-long workshops on emerging technologies in programming, networking, data management, web design, and advanced pedagogies. Educators who have participated in the institutes report that more than 14,000 students benefit each year from lessons that they learned at the institutes.

BATEC-Affiliated Program Enrollments

Community College	2012-13	2013-14	2014-15	2015-16	2016-17
Total Student Population	**11,429**	**12,840**	**13,510**	**14,656**	**15,733**
Gender					
Male	6,197	7,245	7,357	7,495	8,365
Female	5,232	5,595	6,153	7,161	7,368
Ethnicity					
Hispanic or Latino (of any race)	3,088	3,469	3,655	3,943	3,550
Black or African American	3,796	4,585	5,537	7,536	7,051

High School					
Total Student Population	**2,882**	**3,787**	**4,695**	**5,919**	**5,950**
Gender					
Male	1,715	2,234	2,845	3,375	3,460
Female	1,167	1,553	1,850	2,544	2,490
Ethnicity					
Hispanic or Latino (of any race)	780	988	1,294	2,041	2,084
Black or African American	863	893	1,145	2,420	2,448

Since 2013, enrollment of females and minorities underrepresented in STEM fields has increased steadily at BATEC-affiliated community college and high school programs.

CSSIA
National Support Center for Systems Security and Information Assurance

Moraine Valley Community College, Palos Hills, IL
http://cssia.org

National Support Center
for Systems Security and
Information Assurance

CSSIA Addresses Cybersecurity Vulnerabilities

CSSIA provides students with real-world learning experiences in information assurance and network security through initiatives that support new and existing cyberdefense programs. CSSIA's instructional materials cover new and emerging products, technologies, and associated vulnerabilities.

In 2017, CSSIA held a GenCyber camp for 32 secondary school students from inner city and suburban Chicago. The students learned about cybersecurity, coding, and safe online behavior. In a follow-up survey, 84% of the camp students indicated they wanted to attend the camp again next year, and 92% indicated they would recommend the camp to a friend.

Key Activities
• Develops national infrastructure models for cybersecurity skill development by utilizing scalable virtual labs.
• Establishes mentoring programs for secondary school and college educators.
• Expands and enhances cybersecurity skills competitions.
• Recruits women and underrepresented populations.
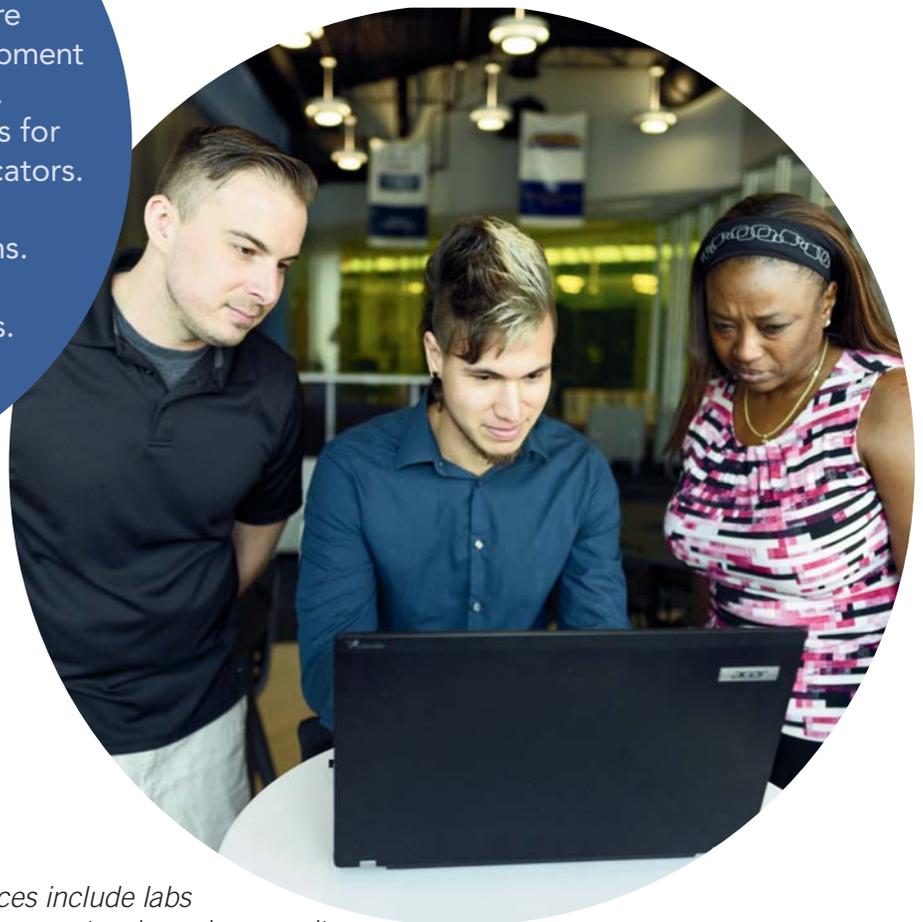
CSSIA's online resources include labs and lessons on local area networks, cybersecurity, forensics, and data recovery.

CSSIA's Professional Development Includes CAE Mentoring

CSSIA shapes the IT workforce by bringing the best and most current courses to faculty. Since 2004, the center has instructed more than 2,000 secondary school teachers and college faculty members in cybersecurity-related topics.

In surveys about CSSIA's professional development, 73% of the 1,460 educators who responded reported that they already use or plan to use CSSIA curricula and instructional materials. Most of the educators contacted in follow-up interviews reported that learning how to implement hands-on, complex laboratory exercises was the most valuable aspect of CSSIA's workshops.

In 2010, CSSIA became one of the first six institutions selected for the National Security Agency/Department of Homeland Security National Centers of Academic Excellence in Cyber Defense Two-Year (CAE2Y) program.

Since becoming a CAE Regional Resource Center in 2016, CSSIA has provided resources and mentoring to faculty at institutions seeking the CAE2Y designation. Attaining this designation involves in-depth program assessments and maintaining rigorous standards. Graduates of CAE programs are highly sought after by employers. As of 2017, CSSIA has directly helped 33 institutions attain CAE status.

"For many years we have partnered with CSSIA at Moraine Valley Community College to help promote the advancement of their students through our IT security internship program. It has been very beneficial for both of our organizations."

Gene Esposito, CEO
ESPO Systems
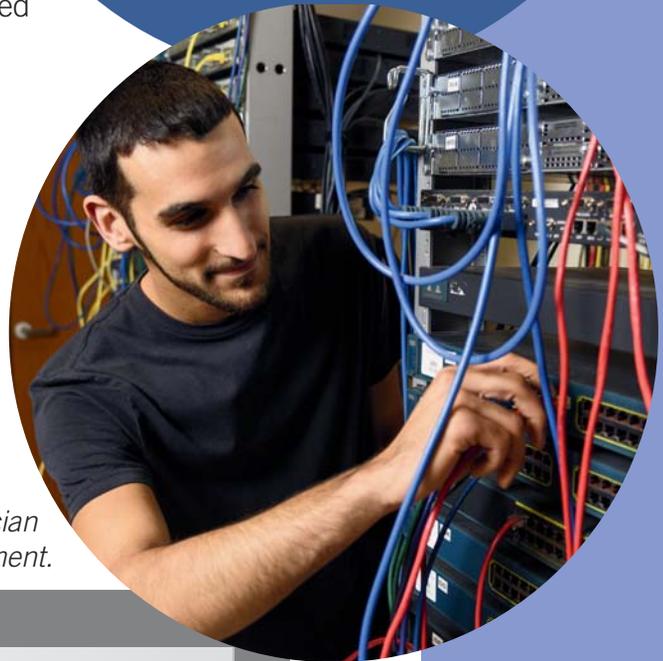
A Moraine Valley Community College student technician reviews the specifications of deployed equipment.

Institutional Usage of CSSIA Curricula

2014	2015	2016	2017
272	281	293	302
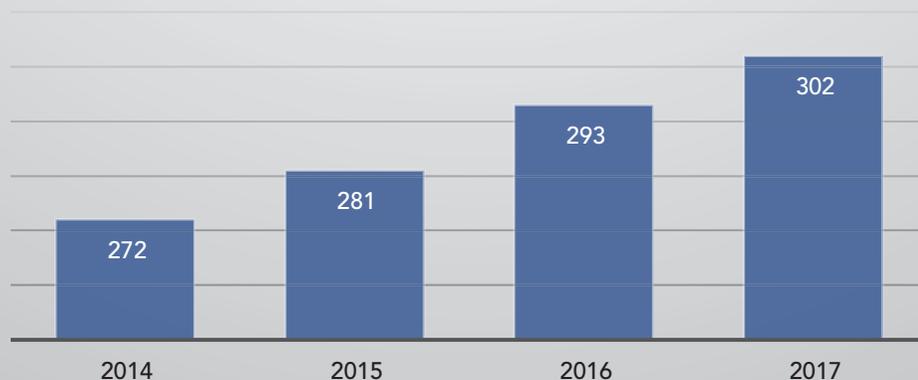
More than 300 higher education institutions have utilized one or more of CSSIA's cybersecurity courses.

CTC
National Convergence Technology Center

Collin College, Frisco, TX
http://www.connectedtech.org
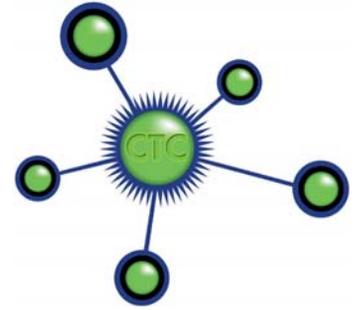
Students Benefit from Working Connections & Convergence College Network

Since 2008, the National Convergence Technology Center's (CTC) professional development events—called Working Connections—have welcomed more than 1,500 information technology (IT) faculty members. Annual longitudinal surveys that measure how educators use the knowledge they learned at Working Connections show that the workshops have directly impacted more than 108,200 students and led to 368 new degree or certificate programs.

CTC also supports the Convergence College Network (CCN) community of practice. Faculty from member colleges attend Working Connections events, share best practices, network with colleagues, and follow CTC's Business and Industry Leadership Team (BILT) model. Data indicate that active CCN involvement improves students' credential completion rates.
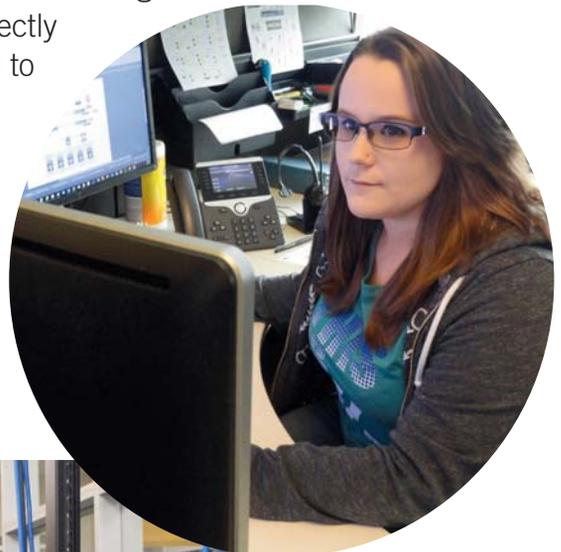
A graduate of a CTC-affiliated IT program manages the IT network of a multi-location financial institution.

Key Activities
• Leads formation of seven regional education hubs to strengthen 2+2+2 articulation.
• Facilitates partnerships between 64 institutions to share curriculum and processes.
• Offers Working Connections professional development for IT faculty.
• Engages its Business and Industry Leadership Team in all activities.

A student configures a classroom server rack for his networking lab.

Highly Engaged 2+2+2 Articulation Pathways Underway

CTC is expanding the influence of its successful BILT model that involves IT business leaders in a program co-leadership role through quarterly virtual meetings and annual entry-level job skills analysis updates. CTC is developing seven regional education hubs led by grant partners to build highly engaged 2+2+2 articulation pathways. These hubs—composed of high schools, community colleges, and four-year universities—will align with workforce demands of their local BILTs from each hub's region. CTC BILT members will mentor regional BILTs in following the CTC model to ensure graduates are highly qualified and readily hirable.

"Leveraging the expertise of educators and the passion of industry leaders, the BILT framework enables powerful collaborations that ensure program curriculum meets employer needs and that students are well prepared for the digitally-transformed workplace."

Mercedes Adams, Manager of Strategic Programs & Academic Alliances NetApp

The National BILT guides CTC and its network of educational institutions across the country in aligning curricula with the ongoing evolution of the IT industry. This includes the development of a new capstone course that focuses on hybrid cloud problems and an exploration of new entry-level job opportunities at the intersection of IT/manufacturing and IT/biotechnology. At the request of the BILT, CTC will research the value of students creating portfolios they can use to demonstrate technical expertise at job interviews.

CTC Program Completion Data

Year	Enrolled Students	Completed Credentials
2014	18,156	7.4%
2015	17,817	10.7%
2016	19,612	11.8%
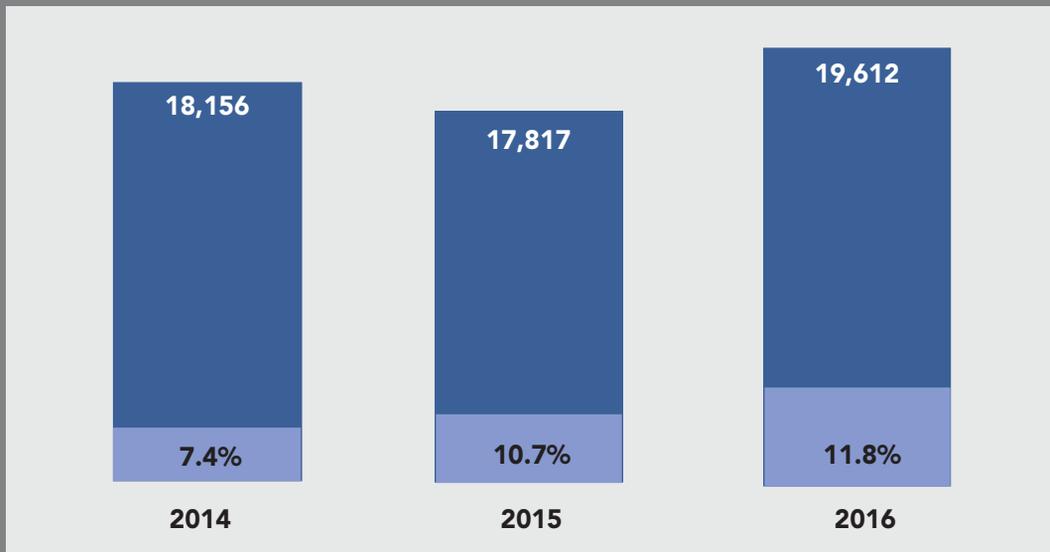
Fifteen CCN member colleges reported increased completions from 2014 through 2016.

■ Enrolled Students ■ Completed Credentials

CWW
CyberWatch West

Whatcom Community College, Bellingham, WA
https://cyberwatchwest.org

CWW
cyberwatch west
The Center for Cybersecurity Education

CWW Offers Online Professional Development

CWW educated 14 faculty members to use course materials on critical infrastructure cybersecurity; a recording of the workshop is available for downloading.

CWW educated 48 faculty members to add intelligence analysis content to their cybersecurity programs. The accompanying model curriculum is available for download.

"Crosswalk" Helps Veterans Obtain College Credits

CWW's "crosswalk" translates military occupational specialties (MOS) into course equivalencies. This tool helps educators more consistently evaluate US veterans' military training and experiences to exempt them from course requirements and award college credits. Educators downloaded the MOS crosswalk more than 100 times since September 2016.

Key Activities
• Disseminates cybersecurity educational resources to faculty.
• Supports faculty professional development and related travel.
• Fosters networking between faculty and industry to build community and workforce initiatives.
• Promotes participation in high school and collegiate student cyberdefense competitions.

Students at cyber camps learn about cybersecurity by playing Cyber Realm.

CWW Builds Workforce with Industry Partners & Educators

CWW sponsored three industry events during the 2016-17 academic year that attracted approximately 200 students, teachers, and representatives of government agencies and regional cybersecurity employers. These networking events—organized at Regis University (CO), Pikes Peak Community College (CO), and San Juan College (NM)—allowed participants to identify common workforce development goals in their respective communities.

CWW's educational membership more than tripled in three years, increasing from 40 in 2014 to 152 in September 2017. Most education members access CWW's professional development, utilize its model curriculum, and interact with employers at industry events.

CWW Recruits Women for Cybersecurity

Increasing the participation of women in cybersecurity is a CWW priority. The center organizes and sponsors programs designed to encourage women and girls to pursue cybersecurity careers: a cyber camp for Girl Scouts, tech workshops for middle and high school girls, a cybersecurity session at the Young Educated Ladies Leading (Y.E.L.L.) Summit. These programs impacted more than 700 women and girls in 2016 and a similar number in 2017.

"Because of partners like CyberWatch West, San Juan College is laying the foundation for the future of our community and expanding the possibilities for our youth."

Toni Hopper Pendergrass, PhD
President, San Juan College

CWW resources help colleges add cybersecurity skills to their information technology programs.

CWW's recruitment of females for cybersecurity careers ranges from camps to workshops and conference travel support.

Women and girls impacted by CWW in 2016

711

335
Learned at tech workshops for middle and high school girls at four campuses

250
Participated in cybersecurity camp for Girl Scouts

121
Attended Young Educated Ladies Leading (Y.E.L.L.) Summit

5
Received travel support for Women in Cybersecurity Conference

89

GeoTech Center
National Geospatial Technology
Center of Excellence

Jefferson Community and Technical College, Louisville, KY
http://geotechcenter.org

10 GeoTech Courses in Use across US

GeoTech created 10 model courses based on the Geospatial Technology Competency Model (GTCM) that it developed with the US Department of Labor. The model provides industry and academia with a list of up-to-date competencies common across all geospatial technology (GST) industry sectors.

Between 2014 and 2017, more than 5,000 unique users accessed the model courses. Course materials include lecture notes, videos, assessments, assignments, learning activities, and case studies. More than 20 institutions have adopted either the full courses or elements of them.

GeoTech's military "crosswalk" is also used across the nation. It awards credit to US military veterans for prior learning and expedites their transition to civilian education.

Key Activities
• Increases the number of people who possess industry-defined geospatial technology (GST) skills.
• Recruits underrepresented populations.
• Provides educators and workers with industry-relevant GST curricula and professional development opportunities.
• Establishes new competency standards—and revises existing ones—for GST occupations.

A technician prepares a hexacopter for flight.

Educators who use GeoTech's courses participate in the Teachers Teaching Teachers GIS Conference.

GeoTech Facilitates Formal & Informal Learning

GeoTech's agreements with professional organizations ensure that the professional and educational GST communities collaborate. GeoTech's interviews with 200 GST professionals, educators, and students influenced the products it has developed.

One of these is the Geospatial Program Finder—the most complete list of geospatial education programs at US two- and four-year colleges. In addition to location and program info, the database notes whether institutions collaborate with K-12 schools; offer graduate work; and grant GST certificates, associate, and/or bachelor degrees.

The center also supports informal GST learning. More than 2,000 GST users participate in the GeoTech Center community of practice that focuses on two-year colleges. GeoTech sponsors undergraduate GST skills competitions both independently and with the Urban and Regional Information Systems Association.

GeoTech's Personal Assessment tool gauges performance of 200 skills involved in 44 geospatial competencies derived from the GTCM. People who use the tool receive individualized recommendations, ranging from in-depth study to formal courses. The overall results provide insights about industry-wide strengths and weaknesses. Data from the first 275 Personal Assessments led GeoTech to enhance course content.

Content Revisions Based on Personal Assessment Scores

Geospatial weaknesses identified in Personal Assessments

- File Management
- Statistics
- Programming
- Query
- Metadata
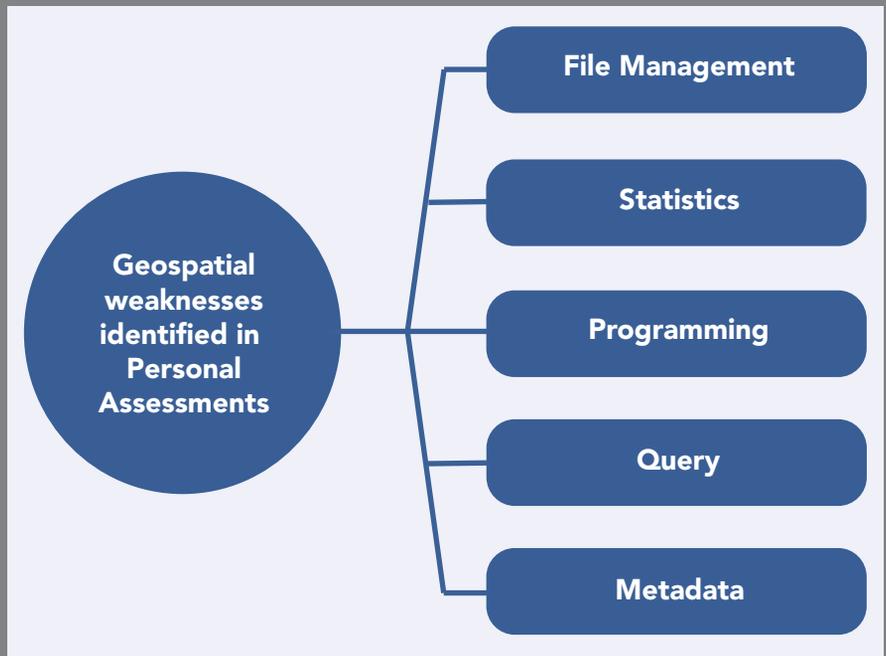
From the scores on the first 275 Personal Assessments, GeoTech revised its course content in key areas.

"GeoTech challenges us—as professional development workshop designers and instructors—to develop curricula and programs that inform educators on the cutting-edge geospatial tools and techniques. We are excited by our collaborative efforts to disseminate quality geospatial education."

Anita Palmer, President
GISetc

National CyberWatch Center

Prince George's Community College, Largo, MD
http://www.nationalcyberwatch.org

NATIONAL
CYBERWATCH
CENTER

National CyberWatch Provides Technical Support to Cybersecurity Programs at Two-Year Colleges

In addition to supplying industry-vetted curricula, National CyberWatch helps colleges start cybersecurity education programs by providing advice via e-mails, teleconferences, and in-person visits.

It also offers comprehensive support and technical assistance for institutions that need to re-designate, as well as those that are new to the National Security Agency/Department of Homeland Security National Centers of Academic Excellence in Cyber Defense Two-Year (CAE2Y) program. This program promotes cybersecurity in higher education, supports development of cybersecurity professionals, and reduces vulnerabilities in the nation's networks.

From 2016 to 2017, National CyberWatch helped increase the number of community colleges earning the CAE2Y designation from 23 to 40.

Key Activities
• Collaborates with industry, academia, and government agencies to strengthen the cybersecurity workforce.
• Sets educational and assessment standards for the information security field.
• Develops new skills-based curricula tied to work roles and professional certifications.

Employers meet cybersecurity students from two-year colleges at the 3CS Job Fair.

National Cyber League competitions simulate the challenges students will contend with as cybersecurity technicians.

Cybersecurity Educators Share Innovations & Strengthen the Workforce

National CyberWatch's large collaborative network of higher education institutions, public and private schools, businesses, and government agencies focuses on advancing cybersecurity education and strengthening the cybersecurity workforce.

In 2017 the center launched Innovations in Cybersecurity Education to spotlight the work of innovative cybersecurity educators and encourage adoption of their promising practices. Five of the 44 submissions were selected as uniquely creative ideas and received special recognition at the 2017 Community College Cyber Summit (3CS). National CyberWatch is sharing all the submissions among stakeholders to build the cybersecurity education community's collective strengths.

"The National Cyber League platform is one of very few resources that give students the hands-on experience required in the field. Facebook places such a high importance on such resources that it has dedicated our own engineering team to assist with the competition."

Jennifer Henley, Director of Information Security Operations
Facebook

Accelerated Learning Programs Boost Current IT Workforce

National CyberWatch's accelerated learning programs integrate validated assessment, instruction, practice labs, and challenge scenarios to improve cybersecurity talent management in organizations.

The center works with industry partners to assess and raise the capability of the current information technology (IT) workforce. These initiatives involve individual development plans (IDPs), personalized instruction, simulated practices, and formative credentialing.

To develop more capable entry-level technicians, National CyberWatch is exploring development of a residency program with IDP-prescribed job rotations and validated, performance-based assessments.

Educator Participation in Community College Cyber Summit (3CS)

Year	Participation
2014	189
2015	278
2016	360
2017	440

Increased participation in 3CS means more educators know about model cybersecurity programs and effective teaching practices.

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Cyber Service! Interdisciplinary & Experiential Education for Cyberforensics Technicians
Union County College, Cranford, NJ
http://ate.community/cyberservice

Innovative Cyberforensics Program Embeds Service Learning

The Cyber Service! project prepares skilled cyberforensics technicians for high-demand jobs in the northern New Jersey and New York City metropolitan region.

It features a series of embedded, stackable certificates that lead to an Associate in Applied Science Cyberforensics degree.

Experiential education and service learning are integrated into the innovative curriculum, which is designed to attract diverse groups of students, keep them engaged, teach them critical workforce readiness skills, and instill in them a commitment for civic responsibility.

Cyber Service! participants will also be prepared to pass industry certification exams, which will facilitate their entry into well-paying cyberforensics careers.

Students learn about decrypting secret messages during Cyber Service! Lunch and Learn programs.

GEOCACHE
Mesa Community College, Mesa, AZ and Northern Arizona University, Flagstaff, AZ
http://ate.is/GEOCACHE

Teachers Raise Awareness of GST Careers

To raise awareness of geospatial technology (GST) careers, the collaborative project Geospatial Connections Promoting Advancement to Careers and Higher Education (GEOCACHE) teaches educators how to incorporate GST into existing courses.

Since 2013, 36 high school and college instructors have participated in Beginning Institutes; 28 participated in Advanced Institutes. Several participants subsequently presented GST lessons at conferences.

At least 1,000 students learned about GST as a result of lessons implemented by 21 institute participants. In post-lesson assessments, college students showed both increased awareness of GST careers and more capability to use maps and spatial data.

In 2018 GEOCACHE developed a statewide GST user group and convened its second educator conference.

Educators improve their technical skills while developing GST lessons for their students.

GeoTech Consortium of Western New York: Get the GIST Certificate

Monroe Community College, Rochester, NY
http://ate.is/GIST

Geospatial Certificate Responds to Job Opportunities

The GeoTech Consortium created a 24-credit geospatial information science and technology (GIST) certificate within Monroe Community College's Associate Degree in Geography.

The certificate program prepares students for employment with businesses and government agencies. It includes internships with employers in the Finger Lakes region where geospatial information scientist and technologist jobs are expected to grow by 10% during the next decade. Entry-level GIST salaries are about $28,000; experienced workers earn about $100,000.

In partnership with GeoTech Center and the New York Geographic Alliance, the consortium provided professional development for 20 high school teachers. Four high schools now offer GIST dual-credit courses.

Intro GIST Course Enrollments

Students Enrolled in Introductory GIST Course
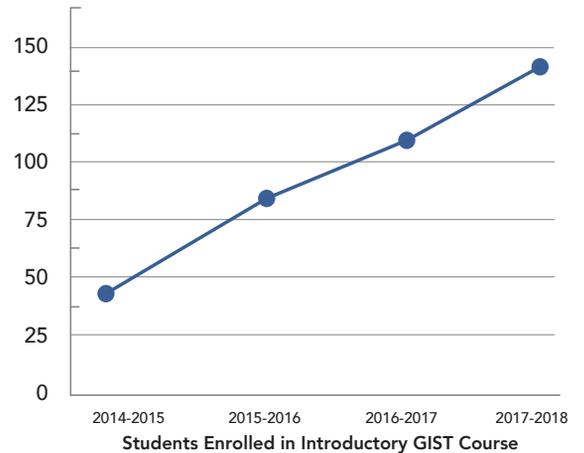
Enrollments in the introductory GIST course have increased steadily with nearly 90% completion rates.

iNoVATE-Expansion Project (iNoVATE-X)

Florida State College at Jacksonville, Jacksonville, FL
http://ate.is/INOVATE-X

Project Gives Students Access to Real-World Networks Virtually

iNoVATE-X uses NETLAB+ Appliance and virtual servers for online instruction of basic and advanced Microsoft server installation, configuration, and administration skills.

The arrangement gives students in rural and underserved areas access to real-world equipment 24 hours a day, seven days a week. It allows instructors to monitor students' progress on assignments and offer specific instruction as needed. This saves colleges money because they no longer need two physical servers and two computers per student for network administration certificate programs.

By building on its previous ATE grant, which provided professional development to 101 educators, the iNoVATE-X project addresses employers' needs for server administrators.

Server Administration Course Enrollments
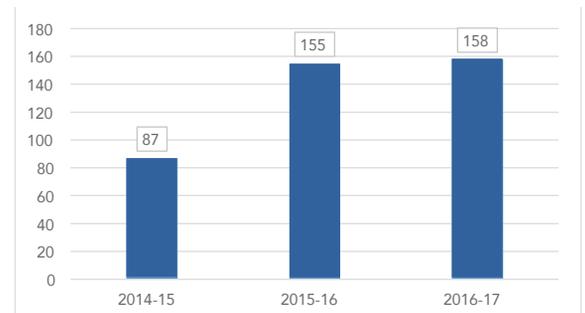
Enrollments in server administration courses grew beginning in 2015-16 when iNoVATE-X's curriculum and virtual servers became available.
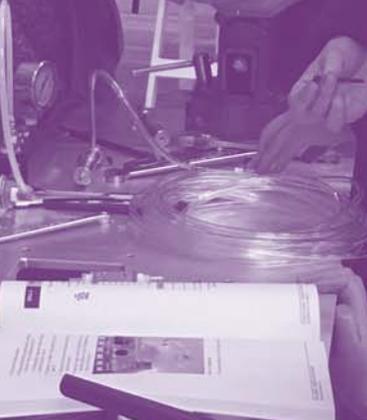
Micro and Nanotechnologies
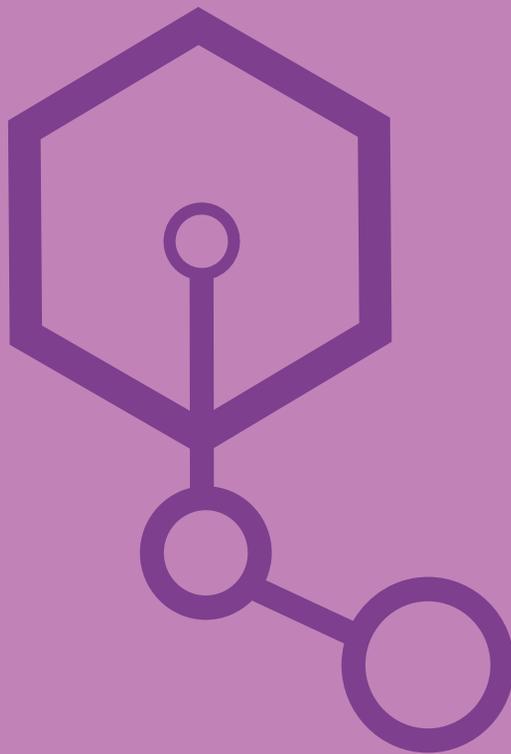
Nano

NACK Support Center
Nanotechnology Applications and Career Knowledge Support Center

Penn State University, University Park, PA
http://nano4me.org

RAIN Network Engages Students' Interest in STEM

The Remotely Accessible Instruments for Nanotechnology (RAIN) network provides educators with web access to state-of-the-art nanocharacterization and nanofabrication tools. This network of 19 universities, colleges, and a K-12 cooperative extension has hosted more than 140 sessions attended by more than 2,600 students. Of those sessions, 87 with 1,834 students were conducted in 2017.

A survey of 600 students who participated in RAIN sessions found a majority of those students reported RAIN sessions were more engaging than traditional textbooks. Another recent study found RAIN sessions increased interest in science among underrepresented students who previously showed no passion for obtaining science degrees.

Key Activities
- Enables nanotechnology workforce education through partnerships with two-year colleges.
- Operates a network for education access to nanotech equipment from remote locations.
- Advocates for international nanotechnology skill standards.
- Utilizes diverse media and dissemination methods to share nanotechnology education materials.

Educators gain hands-on nanotechnology experience during NACK's workshops.

Nanotechnology students have opportunities to work with state-of-the-art equipment through NACK educational programs.

NACK Develops Stackable Certificates Based on ASTM Standards

A strong nanotechnology-based industry must have a workforce skilled in synthesis, fabrication, and characterization at the nanoscale. To improve the preparation of nanotechnicians, NACK partnered with ASTM International to institutionalize NACK's industry-approved core skills into six ASTM standards. Based on these standards, NACK and ASTM are developing stackable certificates for individuals entering the nanotechnology workforce.

"The nanotechnology course set taught by NACK was the sole catalyst for both my academic and industry careers. A decade later, I continue to utilize information gained during that semester on a regular basis."

Zachary Gray, PhD, Applications Scientist
Nanoscience Instruments
2007 Reading Area
Community College Graduate

Growing Audience Taps into NACK's Resources

NACK's library of educational resources continues to grow. NACK's professional development workshops and webinars for educators are being redesigned into a live-streaming format. This use of new media technologies allows both educators and industry technicians to access training from nanotechnology professionals and state-of-the-art equipment from all over the country without having the burden of travel. Recordings of these educational sessions will be made available to participants and added to the collection of resources available to educators on the http://nano4me.org website.

Collaboration with nanoHUB, part of the NSF-funded Network for Computational Nanotechnology, provides another venue for NACK's educational resources. More than 5,600 individuals have registered for NACK's webinars, accessed archived webinars at http://nano4me.org, or watched them on YouTube.

RAIN Sessions & Participants

Year	# of Sessions	# of Students
2015	8	68
2016	48	771
2017	87	1,834
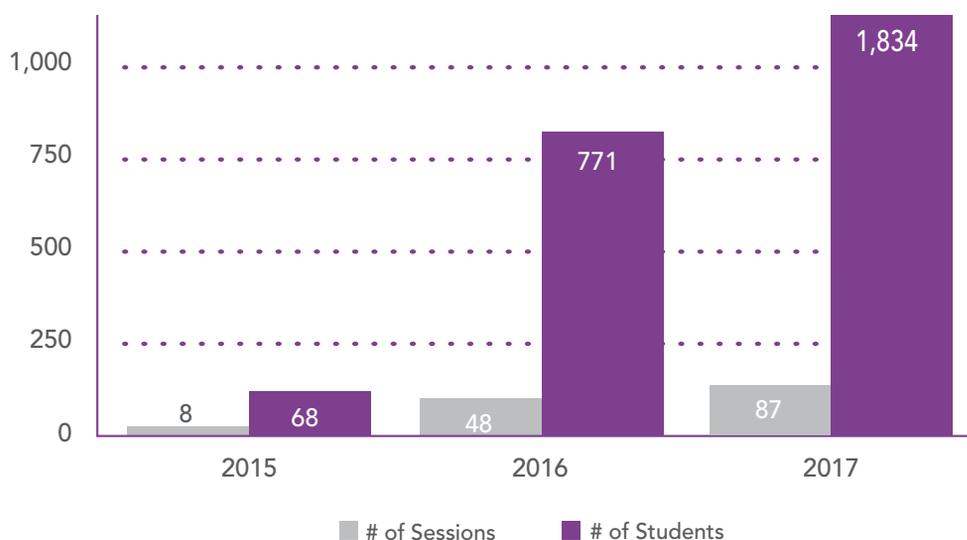
RAIN sessions and student participation have steadily increased since 2015.

Nano-Link
Center for Nanotechnology Education

Dakota County Technical College, Rosemount, MN
http://www.nano-link.org

Nano-Link Tailors Content for Multidisciplinary Use

To help educators incorporate nanotechnology into their existing courses, Nano-Link has tailored the content of its 20 semester-long courses and modules for customization. The center also offers supplemental funding to provide community college faculty with release time for them to add nanotechnology to their existing lessons in various disciplines.

In 2017 Nano-Link introduced more complex modules at the request of educators. These new modules cover photolithography, cellulose fibers, and encapsulation techniques.

The center has also developed nanotechnology competencies to prepare students with the skills to meet employers' needs.

Key Activities
- Offers 20 semester-long nanotech courses to colleges and high schools.
- Provides 20 nanotech modules for instructors to integrate hands-on activities into existing chemistry, physics, biology, math, and other courses.
- Teaches nanotechnology principles to educators at regional workshops.

A student examines the structure of a microchip through a fluorescent microscope.

Instruction of Lakota students and their teachers led to Nano-Link's outreach to other Native American communities.

Spread of Nanomaterials Drives Workforce Changes

Demand remains strong for graduates from the 12 community college programs affiliated with Nano-Link. In the past most graduates were hired by the research organizations of large multinational corporations. With the incorporation of nanoscale materials in many products and the decrease in nanotechnology equipment costs, employers' demand has shifted from specialists to technicians who broadly understand the nanoscale phenomena.

Nano-Link is responding by preparing nanotechnicians for careers in manufacturing, testing, and quality control. Graduates of the Nano-Link Alliance colleges are entering careers that involve quality testing or the use of nanoscale materials in medical device manufacturing, materials science, and electronics.

Nano-Link Takes Nanotech to Tribal Communities

Since 2015 Nano-Link has been working with the Lakota Tribe at Standing Rock Reservation in North Dakota and South Dakota. It has offered educator workshops and visited science classes to teach hands-on, culturally relevant nanoscience modules to Native American students. This successful initiative has led to plans for Nano-Link to offer similar programs with tribal communities in Montana, Idaho, and Washington.

"I want to be the best person on that floor. I want to be the person that when someone needs help with a problem, I'm the one they come to."

*Michael James Agerbeck,
Engineering Technical Specialist, HB Fuller
2010 Dakota County Technical College
Nanoscience Technology
Graduate*

Modules Spark Students' Interest in Nano

Module	Agree or Strongly Agree
Nanoparticles and Sunscreen (n=19)	53%
Unit Cells and Crystal Structures (n=79)	87%
Surface Area to Volume Ratio (n=36)	67%
Superhydrophobicity (n=61)	87%
Scientific Method (n=218)	82%
Ring Polymers (n=109)	77%
Cross-Linked Polymers (n=25)	80%

Agree or Strongly Agree That Modules Increased Their Interest in Nanotechnology
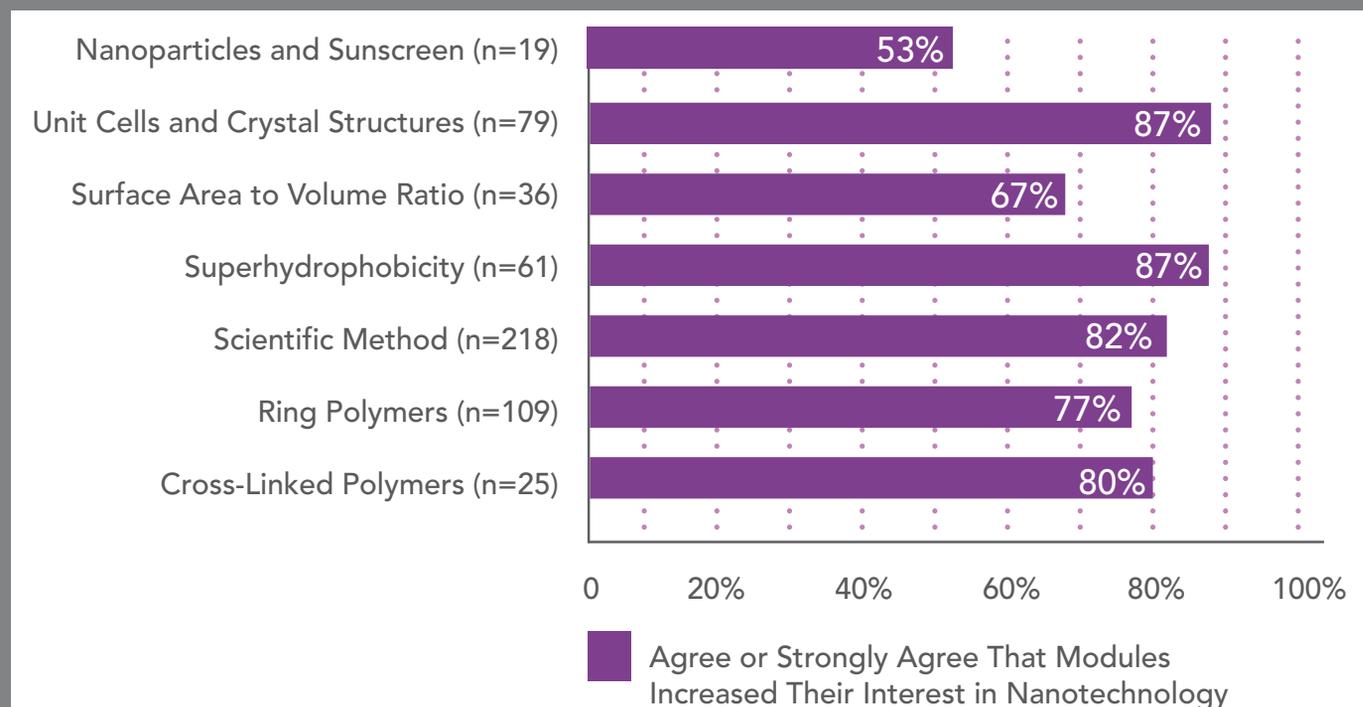
More than 80% of the students who used Nano-Link's most popular modules indicated on surveys that the lessons piqued their interest in nanotechnology.

NEATEC
Northeast Advanced Technological Education Center

SUNY Polytechnic Institute, Albany, NY
http://neatec.org

Northeast Advanced
Technological Education Center

NEATEC Offers Courses & Internships

NEATEC's enhanced course offerings include an online introductory nanotechnology course utilized by seven high schools; two nanotechnogy courses offered at Westchester Community College; and a new six-course silicon photonics certificate program that will bring students to SUNY Polytechnic Institute for hands-on activities.

Key Activities
• Offers workshops and short courses to students and faculty of 2- and 4-year colleges.
• Places students in paid industry internships.
• Provides professional development and kits to educators who embed nanotechnology modules into high school and community college courses.
• Offers workshops to new employees of semiconductor manufacturers.
• Offers online nanotechnology course.

To facilitate experiential learning opportunities, the center selects students from New York community colleges for 16-week paid internships. Since 2015, more than 100 students have completed internships with six different companies that have research facilities at SUNY Polytechnic. Thirty additional students have completed internships at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD.

"I have been lucky enough to attend five NEATEC workshops. They have really helped me apply theory-based knowledge acquired with traditional schooling into real-world situations…NEATEC workshops contributed to my being hired in an amazing position in thin films technology."

Terrance Barker, Process Engineer
Tokyo Electron Limited (TEL)
Hudson Valley Community College
Electrical Engineering Graduate
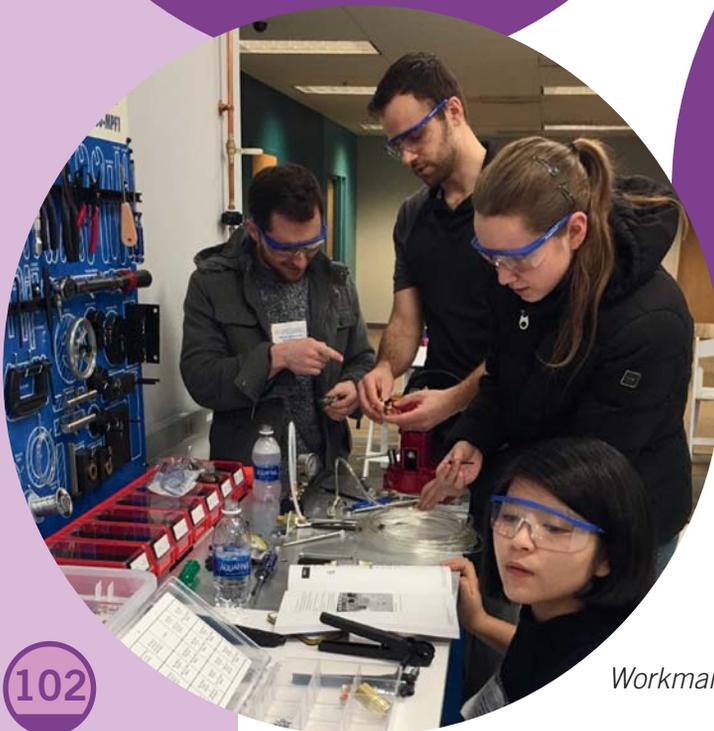
Workmanship skills are woven into NEATEC's curriculum.

NEATEC Expands Programs for Educators, Technicians & Veterans

NEATEC builds the workforce by offering professional development to New England educators; by providing technical workshops for new employees of high-tech companies; and by preparing US Army veterans for civilian careers.

NEATEC teaches high school teachers and community college instructors how to embed nanotechnology modules into existing STEM courses. NEATEC is on track to have more than 10 modules available in 2018. The educators receive instructional materials including kits with hands-on classroom activities. The 88 educators who attended the professional development programs in 2017 have already taught nanotechnology lessons to 1,800 students.

NEATEC provides training for GLOBALFOUNDRIES, Panasonic, and other high-tech companies. In technical workshops that last from two to five days, NEATEC instructs new cleanroom technicians in company-specific tool management, maintenance, and troubleshooting. Income from these employee training sessions is a key component of the center's sustainability plan.

To help retiring military personnel find employment with advanced manufacturers, the center launched the Soldier for Life-Transition Assistance Program with Mohawk Valley Community College (NY). At multiday workshops soldiers from Fort Drum (NY) meet employers and learn about mechatronics, nanotechnology, and hydraulics.

A technician and engineer work on a diffusion process in the Fab 8 cleanroom at GLOBALFOUNDRIES.

Participants of NEATEC's Educational Activities

- Online Course — 30
- Experiential Learning (internships, job shadowing, co-ops) — 160
- Workshops for Community College Faculty & Students — 232
- Workshops for Employed Technicians — 60
- Professional Development for Teachers of Grades 6 to 12 — 105
- Soldiers Attending Fort Drum Workshops — 43
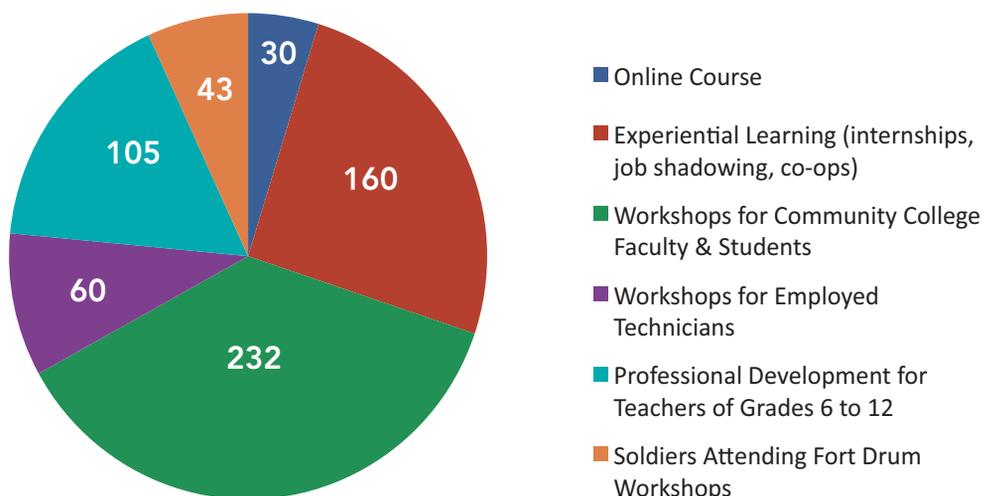
NEATEC's workforce development initiatives focus on students, educators, technicians, and soldiers transitioning to the civilian workforce. In 2016-2017 alone, 1,054 students benefited from their teachers' learning from professional development modules.

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SCME
Support Center for Microsystems Education

University of New Mexico, Albuquerque, NM
http://scme-support.org

SCME

Modules, Courses, Kits & Workshops
Spread Microsystems Know-how

SCME supports two-year, four-year, and secondary school students and instructors with relevant, hands-on, and application-based microsystems curricula. The center engages students and instructors with training and mentoring through face-to-face cleanroom and classroom workshops, outreach activities, and online coaching. SCME currently offers 56 learning modules, six asynchronous online short courses, 11 hands-on classroom kits, and cleanroom workshops at the University of New Mexico.

Since 2005, SCME has helped to bring microsystems education to 19,000 students across 38 states and 13 countries while collaborating with learning institutions and other ATE centers to expand and evolve microsystems education throughout the United States and beyond.

Key Activities
- Provides free educational materials for instructors and students.
- Supplies hands-on kits, online instructor training, and online student courses.
- Offers cleanroom workshops and access to microtechnology and nanotechnology partnerships.

At SCME workshops educators use plasma etchers and other micro and nanotechnology tools.

SCME Helps Technicians Adapt to Microsystems in New Technologies

SCME educates students and transitioning workers for the needs of the rapidly growing microsystems industry, which Yole Development predicts will have 12% compound annual growth through 2022. As a support center, SCME will grow the number of innovative online short courses (48 by 2021) and continue to provide educational resources, professional development, and mentoring opportunities. SCME's core competency content in electronics, microfabrication processes, microsystem applications, and microsensor design prepares students for careers in emerging technology fields.

SCME's newest partner, Lone Star College, will integrate relevant modules into its biotechnology laboratory technician program over the next four years. SCME industry advisory board members and their companies (Honeywell, Texas Instruments, NXP, HT Micro, 3D Glass, Sandia National Laboratories) will do the beta tests. They also plan to review the short course offerings while assisting with the development of a certificate program that will be supported by the Association of Technology, Management, and Applied Engineering (ATMAE). With its large community of practice, SCME will continue to support industry and academic needs to grow and enhance the workforce.

"If SCME did not exist, our program would not exist. We would not be able to train technicians for 21st century careers in emerging technology."

Rick Vaughn, Faculty Chair
of STEM Initiatives
Rio Salado College

SCME Faculty & Students

Year	Total Faculty	Total Students
2012	211	494
2013	178	2,873
2014	236	4,665
2015	191	2,816
2016	163	2,581
Totals	979	13,429

During its most recent grant, SCME educated hundreds of educators and thousands of students via its online courses, face-to-face workshops, and instructional materials.

Technicians work together to align and characterize a critical microelectromechanical systems sensor component.

Alamo Institute for Materials Technology (AIM-TEC)

Northwest Vista College, San Antonio, TX
http://ate.is/AIM-TEC

AIM-TEC Offers Students Internships & Mentoring

AIM-TEC's self-sustaining and replicable regional workforce model leverages resources and partnerships to prepare technicians for careers in microtechnology, biotechnology, and nanotechnology materials.

With ATE support Northwest Vista College updated its nanotechnology degree and added manufacturing and biotechnology courses for an Associate in Applied Science in Advanced Materials Technology degree.

Through partnerships with industry and regional stakeholders the project offers work-based education environments and internships.

An advanced materials technology student, who is also a Nano Ambassador, uses atomic resolution microscopy.

To improve recruitment and graduation rates, AIM-TEC links students who participate in Nano Club with support networks and mentoring. Students are also eligible for Nano Ambassador Scholarships for their assistance with technology demonstrations for secondary school students.

DELIVER

Normandale Community College, Bloomington, MN
http://www.normandale.edu/vacuumtech_nsf

Hands-on Technical Education DELIVERed via Telepresence

The Distance Education and Learning In Vacuum technology for Employment Readiness (DELIVER) project educates vacuum technicians, who are critical to national defense and advanced manufacturing. "Vac Techs" repair the complex vacuum systems used to create touch screens, computer chips, and military equipment.

DELIVER provides three, semester-length courses that integrate hands-on practice with vacuum equipment trainer (VET) systems developed by DELIVER staff and industry advisors.

DELIVER ships VET systems to off-site partners, while telepresence technologies bring students face-to-face with instructors. This enables students across the US to earn vacuum technology certificates and enter the workforce with in-demand knowledge and skills.

Telepresence technologies—cameras, microphones, and video screens— bring students face-to-face with instructors as they practice hands-on skills with DELIVER's vacuum equipment trainer system.

FMCC TECH-Lane

Fulton-Montgomery Community College, Johnstown, NY
http://ate.is/TECHL

TECH-Lane Shortens Paths to Electrical Technology Careers

TECH-Lane's two pathways expedite teenagers' entry into semiconductor manufacturing and advanced manufacturing careers in the Tech Valley Corridor.

To maximize students' academic time, TECH-Lane's curriculum and course schedules enable students attending the nearby Pathway in Technology Early College High (PTECH) School to take electrical technology degree courses at Fulton-Montgomery Community College; and students from 14 school districts to use the career and technical center infrastructure to complete a year of the electrical technology associate degree prior to high school graduation.

After touring a business that makes audio amplifiers, 23 eighth graders built their own amps; 43% of the participants were girls.

To excite students about career opportunities and inform their course selections, TECH-Lane offers engaging technical career awareness activities at summer camps.

Microsystems Certification Project

Ivy Tech Community College, Fort Wayne, IN
http://ivytech-mems.org

Innovative Students Improve Instructional Kits

The Microsystems Certification Project developed and tested three microelectromechanical systems (MEMS) courses for use by institutions that do not have cleanrooms.

The project employed students in a discovery-based learning process to develop hands-on MEMS kits using Arduino UNO, customized shields, and LabVIEW software. The kits complement online and in-person versions of the three MEMs courses, which are electives for a certificate within Ivy Tech's Electronics and Computer Technology Associate in Applied Science degree program.

During the project, five Ivy Tech students attended workshops at Chippewa Valley Technical College (WI), and five attended workshops at the Support Center for Microsystems Education (SCME) at the University of New Mexico.

Some of the students who attended a Pressure Sensor Workshop at SCME's cleanroom were involved in improving two of SCME's hands-on MEMS instructional kits and creating three new kits.

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Advanced Manufacturing
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Engineering
Information and Security
Micro and Nanotechnologies

Materials and resources created by ATE centers and projects can be found on the websites listed inside or via ATE Central (http://atecentral.net).

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